Section E

Stream Channel Condition

Introduction

This report provides the results of a level II assessment of the stream channels of the Mendocino Redwood Company (MRC) ownership in the Noyo River watershed analysis unit (WAU). The assessment was done following the methods described in the Watershed Analysis Manual (Version 3.0, Washington Forest Practices Board). The stream channel analysis is based on field observations, aerial photo interpretation and existing stream channel information from Louisiana-Pacific's Sustained Yield Plan.

The goals of the assessment were to determine the existing channel conditions and identify the sensitivity of the channels to wood and sediment. Stream channels are defined by the transport of water and sediment. A primary structural control of a channel in a forested environment, besides large rock substrate, is from woody debris. Channel morphology and condition therefore reflect the input of sediment, wood and water relative to the ability of the channel to either transport or store these inputs (Sullivan et. al., 1987)

Stream channel conditions represent the strongest link between forest practices and fisheries resources. Changes in channel condition typically reflect changes to fish habitat. Because of this the fish habitat and stream channel assessments were done in the same reaches. The results for the fish habitat parameters are presented in Section F - Fish Habitat Assessment.

Methods

The methods of the stream channel assessment are designed to identify channel segments which are likely to respond similarly to changes in sediment or wood and group them into distinct geomorphic units. These geomorphic units enable an interpretation of habitat-forming processes dependent on similar geomorphic and channel morphology conditions. The channels are also evaluated for current channel condition to provide baseline information for the monitoring of channel conditions over the long term.

Stream Corridor Delineation

The stream channel network for the Noyo WAU was partitioned into stream segments based on three classes of channel confinement and several classes of channel gradient. These classifications were based on channel classifications prepared from digital terrain data in the Mendocino Redwood Company's Geographic Information

System (GIS). Channel segments were delineated based on either a change in slope class or change in channel confinement. The slope classes used for delineation are 0-1%, 1-2%, 2-4%, 4-8%, 8-12%, and 12-20%. Channel confinement was classified by confined, moderately confined, and unconfined. Confined channels have a valley to channel width ratio of <2, moderately confined channels have a valley to channel width ratio of <4, and unconfined channels have a valley to channel width ratio of >4. Channel slope class or confinement information from the GIS was re-classified based on field observations. The stream segments are shown on Map E-1.

Field Measurements and Observations

Selection of field sites for stream channel observations was based on gathering a representative sample of response (0-3% gradient) and transport (3-20% gradient) channels from each planning watershed of the WAU. Little attention was focused on the source reaches (>20% gradient), this was assumed to be covered in the mass wasting analysis.

For each channel segment the bankfull width, bankfull depth, approximate valley width, flood plain connectivity and channel slope were taken at several locations along the segment. Stream-bed sediment characteristics were measured by pebble counts, observations of gravel bars, channel aggradation or degradation, and particle size of the stream bed material. The segment was further classified by its morphology type based on Montgomery and Buffington (1993) and Rosgen (1994). Large woody debris (LWD) in channel and potential recruitment trees was tallied. The abundance and type of pools were also observed. The field observations notes are in the appendix of this module. The field observations are summarized and defined in Table E-1.

Interpretations of Field Assessments

Interpretations related to sediment supply, transport capacity and LWD response were the basis for development of geomorphic unit classifications. These interpretations were based primarily on existing conditions observed in the channels and potential responses to changes to input factors as discussed in Montgomery and Buffington (1993).

Geomorphic Units

Channel segments were grouped into geomorphic units by similar attributes of channel condition, position in the drainage network, and gradient/confinement classes. The intent of the geomorphic units are to stratify channel segments of the WAU into units which respond similarly to the input factors of coarse and fine sediment, and LWD. These geomorphic units can then be interpreted to have similar habitat-forming processes.

Interpretations related to sediment supply, transport capacity and LWD response were the basis for development of sensitivity of geomorphic units to coarse sediment, fine sediment and LWD inputs. These interpretations were based primarily on existing conditions observed in the stream channels of the WAU. The channel sensitivity to changes to coarse sediment, fine sediment and LWD are based on how the current state of the channel is likely to respond to inputs of these variables.

Long-Term Stream Monitoring Sites

To monitor stream channel morphology conditions and stream sediment characteristics related to fish habitat, long term stream channel monitoring segments were established in the Noyo WAU. Along these segments a thalweg profile, several cross sections and streambed D50 measurements were surveyed. Stream gravel bulk samples and permeability are also measured but presented in the Fish Habitat module of this report. The long-term stream channel monitoring segment locations are shown on Map E-1 and the protocol described below.

Stream Thalweg Profile and Cross Section Protocol:

The stream monitoring segment for thalweg profile and cross section surveys start at known reference points along the channel and continue upstream 20-30 bankfull channel widths in length. Cross section surveys were taken approximately every 5-8 bankfull channel widths along the segment. Reference points that mark the upstream and downstream ends of the monitoring segment were permanently monumented with rebar pins for future surveys.

Thalweg Profile

Working upstream, the thalweg depth (elevation) and distance along the stream was surveyed. The thalweg is the deepest point of the flowing channel, excluding any detached or "dead end" scours and/or side channels. These areas were excluded in the thalweg profile. At every visually apparent change in thalweg location or depth, the distance from previous thalweg depth location was measured and the elevation taken. In the absence of visually apparent changes, thalweg measurements were taken every 15-20 feet up the center tape.

As specific landmarks were encountered along the reach, (e.g. tributary channels, particularly large pieces of woody debris, permanent survey stakes, armored bend, or other features of interest) the recorder made note of their location and size. Where a channel split into two components, the surveyor decided which is the main channel and then continued moving upstream (making measurements) along that channel.

Cross Sections and D50

Approximately every 5-8 bankfull channel widths along the thalweg profile, the location for a cross section survey was monumented and recorded in the thalweg profile survey notes. The cross sections are placed along relatively straight reaches of channel. Cross sections were surveyed from above the bankfull channel margins on both banks. At least 3-5 cross sections were taken along the monitoring reaches.

Cross section rebar pins were established at both ends of the cross section well above the bankfull channel margin to monument the cross section location. The elevation and the distance from the left bank pin was measured at least every five feet or at any visually apparent topographic change along the cross section. At each cross section a pebble count was conducted, to determine the D50 of the cross section, by measuring 100 randomly selected pebbles along the transect.

Results

Current Stream Channel Conditions

Field channel surveys were done on 24 stream segments, with observations on 7 additional stream channel segments in the Noyo WAU during the summer of 1998. Table E-1 provides a summary of the data collected (see appendix of this module for field forms). Further detail specific to in-channel habitat relationships is found in Section F - Fish Habitat Assessment of this report.

Geomorphic Units

Individual channel segments were categorized into geomorphic units using the interpretation of channel networks described above, the topography the channel segments are found in, the position in the drainage network, and gradient/confinement classes. Six geomorphic units were established to represent the range of channel conditions and sensitivities to input factors of coarse and fine sediment and LWD. The spatial distribution of these six geomorphic units is shown on Map E-1.

Long Term Stream Monitoring

During the Summer of 1998 seven long term channel monitoring segments were surveyed for thalweg profiles and cross sections in the Noyo WAU. Those segments are segment 1, 23, 104, 106, 118, 153 and 159 (see Map E-1). This was the first year that this data was collected, so there is no temporal or comparative analysis that can be done. This represents the base line condition for future monitoring. The plots of the surveys are included in the appendix of this module (Appendix E) for display. The results of the stream gravel bilk samples and permeability are presented in section F - Fish Habitat Assessment of this report.

Table E-1. Stream Segment Field Observations for Noyo WAU

					Stream Channel Dimensions					
Segment Name	ID #	Geomorphic Unit	Channel Confinement	Survey Length (ft)	Mapped Slope Category	Observed Slope	Mean Bankfull Depth (ft)	Mean Bankfull Width (ft)	Width/Depth Ratio	Valley Width
Noyo	56	1	c	1300	0-1	1	5	34.8	7.0	>500
Noyo River	1	1	c	1564	0-1	1	5.4	53	9.8	57.5
NF Noyo	3	1	c	1451	0-1	<1	4.6	42.2	9.2	45
Hayworth	104	1	c	790	0-1	1	4.8	29	6.0	29
NF Noyo	152	1	c	656	1-2	1	4.9	25.4	5.2	32.4
Olds Creek	57	2	c	590	1-2	1	5	27.2	5.4	56.5
Marble Gulch	23	2	c	617	1-2	3	4.3	19.5	4.5	31.2
Hayworth	106	2	mc	1074	1-2	1	4	35.8	9.0	63.8
Hayworth	118	2		815	2-4	2	4.1	30.3	7.4	
NF Noyo	152 (upper)	2	c	848	1-2	2	4.4	34	7.7	
Redwood Creek	92	3	c	725	1-2	1	6	41	6.8	1000
Redwood Creek	92 (upper)	3	uc	1066	0-1	1	5.2	39.2	7.5	>500
Burbeck trib.	80	3	uc	500		2	3.8	24.2	6.4	
Upper trib of Noyo trib	64	3	uc	300	2-4	2.6	3.6	9.6	2.7	>400
Unnamed trib of Noyo	63	3	uc	658	0-1	<1	4.6	17.4	3.8	
Gulch # 7	48	3	uc	339	2-4	2	3.5	14.3	4.1	n/a
MFNF	153	3	c	714	2-4	1	4.4	23.4	5.3	
MFNF	153 (upper)	3	c	458	2-4	2	4.2	21.7	5.2	
NF Noyo	159 (lower)	3	c	906	1-2	1	4.8	22.8	4.8	>500
NF Noyo	159 (upper)	3	c	535	1-2	1	5.1	18.8	3.7	
MFNF	156	4	c	672	4-8	4	4.2	23	5.5	41.3
DeWarren Creek	161	4	c	500	4-8	5	3.9	11	2.8	35
NF Hayworth	112	4	c	600	4-8	4	3.2	30.2	9.4	45
Soda Creek	119	4	c,mc	500	2-4	4	4.1	17.8	4.3	
(Noyo)	70	5				5, 1-2				
NF Hayworth	143	6			>20					
(Rdwd creek)	97/98/100/102	5,6				3, 7				
(Burbeck)	81					5				

Table E-1 (continued). Stream Segment Field Observations for Noyo WAU

Sediment/bedform Characteristics												
ID #	Montgomery/ Buffington Class	Rosgen Class	Floodplain Continuity	Aggradation/ Degradation in Past	Aggradation/ Degradation Current	Channel Roughness	Gravel Bar Abundance	Gravel Bar Type	Gravel Bar Proportion Class	Fine Sediment Abundance	Fine Sediment Type	D50 (mm)
56	p-r,pb	F3	I	n	n	b-c	f	p-m	1	m	n/a	32-45
1	p-r,pb	F3	N	y/a	n	c-f	c	a-p	1	m	b	32-45
3	p-r	F3, C3	N	n	n	c-r	c	a-p	1	s	p	45-64
104	p-r,pb	F1,F2	N	n	n	r-c-f	none	n/a	n/a	s	p	90-128
152	p-r	F1,F3	N	y/a	n	r-c-f	f	p	1	s	p	64-90
57	p-r,pb	F3	I	n	n	c	f	p-m-a	1	m	b	32-45
23	p-r	G1, G3	N	n	n	r-c-f	f	a	1	m	b	32-45
106	fp-r,p-r	C3	D-N	y/d	n	c-f-w	c	p-m		m-a	p-r	64-90
118	p-r	B3,B2	I	n	n	b-c-r	f		1	m	p-r	128-180
152 (upper)	p-r	C3,F3	D	y/a	n	c-bk-f	c	p-a-m	2	s	p	45-64
92	p-r	F3	D	n	n	c-f	f	m		s	p	32-45
92 (upper)	p-r,pb	F3	D	n	y/a	c-f-w-bk	a	a-m-p	2	m	p	45-64
80	p-r,pb	F3	D	n	n	c	f	p	1	m	p-b	91-128
64	p-r,sp	B3	D	n	y/d	c-r	f	n/a	1	s	p	n/a
63	p-r	F3	D	y/a	n	c-r-f	f	p	1	s	p	32-45
48	p-r	F3,F4	C	y/a	n	c	c	p-f	2	m	b	32-45
153	p-r	B3	C	y/a	y/d	c-bk-f	c	p-a-m	1	s	p	64-90
153 (upper)	p-r	F3	D	n	y/a,y/d	c-f	c	p-m-a	2	m	p	45-64
159 (lower)	p-r,pb	C3	D	y/a	n	c-f-bk-r	f	p-m		m	p	32-45
159 (upper)	p-r	F3	D	y/a	n	c-r-bk	c	f-p	1	m	p-b	45-64
156	sp	G3, A3	N	n	n	c-b	f	a-f	1	a	b	45-64
161	sp,fp-r	A3	N	y/a	y/a,y/d	b-c-bk-lwd	f	f		m	b	32-45
112	sp	B2,A2	N	y/a	n	b-c-bk-lwd	f	a	1	s	p	128-180
119	fp-r,sp	G4,G3	N	y/a,y/d	y/d	c-w-bk	c	a		a	b	32-45
70		B4?	C			c				s	p	
143	c			n	y/a,y/d	c				s		
97/98/100/102												
81	sp		D-I		y/d	b-c	c	p-a		s	p	

Table E-1 (continued). Stream Segment Field Observations for Noyo WAU

Large Woody Debris Survey											
	Active Channel				Bankfull Channel				Overall		
ID #	Functional LWD (# pieces)	Functional LWD (# /100 m)	Key LWD (# pieces)	Key LWD (# /100 m)	Functional LWD (# in bfull)	Functional LWD (bf #/100m)	Key LWD (# in bfull)	Key LWD (bf #/100m)	LWD Abundance	Percent Current/Relic Recruitment	# of LWD Accumulations
56	3	0.757	1	0.252	5	1.262	2.000	0.505	s	n/a	1
1	10	2.097	2.000	0.419	11	2.307	2.000	0.419	s	90/10	0
3	1	0.226	4.000	0.904	8	1.808	4.000	0.904	s	n/a	0
104	0	0.000	0.0	0.000	2	0.830	0.0	0.000	s	n/a	0
152	4	2.000	0	0.000	4	2.000	1.0	0.500	s	n/a	0
57	2	1.112	0	0.000	0	0.000	0.000	0.000	s	100/0	0
23	5	2.658	3.0	1.595	6	3.190	6.0	3.190	s	65/35	0
106	3	0.916	0.0	0.000	5	1.527	1.0	0.305	s	60/40	0
118	11	4.427	1.0	0.402	80	32.196	14.0	5.634		70/30	5
152 (upper)	9	3.481	3.0	1.160	16	6.189	3.0	1.160		70/30	2
92	12	5.429	2	0.905	13	5.881	0.000	0.000	s	n/a	
92 (upper)	35	10.769	5	1.538	38	11.692	6.000	1.846	a	n/a	3
80	5	3.280	0	0.000	1	0.656	2.000	1.312	s	80/20	1
64	7	7.653	0.000	0.000	2	2.187	0.000	0.000	s	100/0	1
63	22	10.967	4.000	1.994	5	2.492	2.000	0.997	s	n/a	3
48	15	14.513	3.000	2.903	15	14.513	3.000	2.903	c	80/20	2
153	19	8.728	0.0	0.000	22	10.106	1.0	0.459	s	90/10	3
153 (upper)	13	9.310	1.0	0.716	15	10.742	3.0	2.148	c	90/10	2
159 (lower)	10	3.620	4.0	1.448	27	9.775	4	1.448	s	90/10	3
159 (upper)	24	14.714	0.0	0.000	26	15.940	0.000	0.000	s	95/5	2
156	15	7.321	6.0	2.929	25	12.202	7.0	3.417	c	n/a	6
161	51	33.456	11	7.216	51	33.456	15	9.840	a	80/20	4
112	1	0.547	2.0	1.093	31	16.947	26.0	14.213	a	10/90	5
119	55	36.080	11	7.216	66	43.296	16.0	10.496		20/80	8
70											
143											
97/98/100/102											
81											

Table E-1 (continued). Stream Segment Field Observations for Noyo WAU

	Pools								
ID #	Free	LWD Forced	Boulder Forced	Bank Forced	Total # Pools	Pool Spacing	Mean Residual Pool Depth (ft.)	Shade Canopy %	Comments
56	1	0	2	4	7	5.3	2.5	79	
1	1	1	1	1	4	7.4	3.1	74	
3	3	0	0	4	7	4.9	1.6	82	
104	8	0	1	0	9	3.0	2.8	76	
152	6	0	0	2	8	3.2	1.9	76	
57	0	0	0	3	3	7.2	1.9	90	
23	6	0	0	5	11	2.9	1.5	86	
106	3	0	0	5	8	3.8	1.8	88	
118	1	3	1	2	7	3.8	1.2	48	
152 (upper)	0	3	0	5	8	3.1	2	75	
92	2	2	0	3	7	2.5	1.6	84	primarily entrenched channel in strath terraces
92 (upper)	1	5	1	4	11	2.5	2.8	81	
80	0	1	0	1	2	10.3	1.7	99	
64	2	1	0	0	3	10.4	0.8	84	
63	2	4	0	3	9	4.2	1.5	87	
48	0	5	0	2	7	3.4	1.5	86	
153	1	1	0	5	7	4.4	1.2	83	
153 (upper)	0	2	0	3	5	4.2	1.3	89	
159 (lower)	1	3	1	2	7	5.7	1.9	87	
159 (upper)	1	2	0	2	5	5.7	1.6	84	
156					n/a			78	
161	0	4	0	0	4	11.4	1.2	90	
112	0	1	3	0	4	5.0	1.2	59	primarily step pools, so many small pools
119	0	9	0	0	9	3.1	1.7	92	
70									observations only
143									observations only
97/98/100/102									observations only
81									observations only

Key to Table E-3

Stream Channel Dimensions

Category	Description
ID #	the stream idenitification number (see Map E-1).
Geomorphic Unit	number of the geomorphic unit the channel segment is in.
Confinement	c = confined, mc = moderately confined as classified from USGS topography
Survey Length-	length of segment surveyed.
Mapped Slope Catogory	the slope category as defined from USGS topography.
Observed Slope	mean slope observed in field.
Mean Bankfull Depth	mean bankfull depth of surveyed segment, as observed in field.
Mean Bankfull Width -	mean bankfull width of surveyed segment, as observed in field.
Width/Depth Ratio	bankfull channel width to depth ratio.
Valley Width	valley bottom width, from the edges of the slope break of the channel inner gorge, estimated in field.

Sediment/Bedform Characteristics

Category	Description
Montgomery/ Buffington Class	the channel type: p/r = pool/riffle, fp/r = forced pool/riffle, stp = step pool, plnbed = plane bed, cas = cascade.
Rosgen Class	Rosgen channel classification, see Rosgen (1994).
Floodplain Continuity	description of floodplain/channel interaction: C = continuous, D = Discontinuous, I = inactive, N = no floodplain.
Aggredation/Degradation in Past	evidence of past aggregation or degradation of channel.
Aggredation/Degradation Current	currrent aggregation or degradation of channel.
Channel Roughness	B =boulders, C=cobbles, F=bedforms, V=live woody veg., W=large woody veg., R=bedrock, Bk=banks and roots
Gravel Bar Abundance	F=few, C=common, A=abundant
Gravel Bar Type	A=alternate, F=forced, P=point, M=medial
Gravel Bar Proportion Class	Proportion of streaqm segment in gravel bars: 1 = 0-25%, 2 = 25-50%, 3 = 50-75%, 4 - 75-100%.
Fine Sediment Abundance	S=sparse, M=medium, A=abundant
Fine Sediment Type	type of fine sediment accumulation: P=isolated pockets, B=bars
D50	the median gravel size of the stream bed

Key to Table E-3 continued.

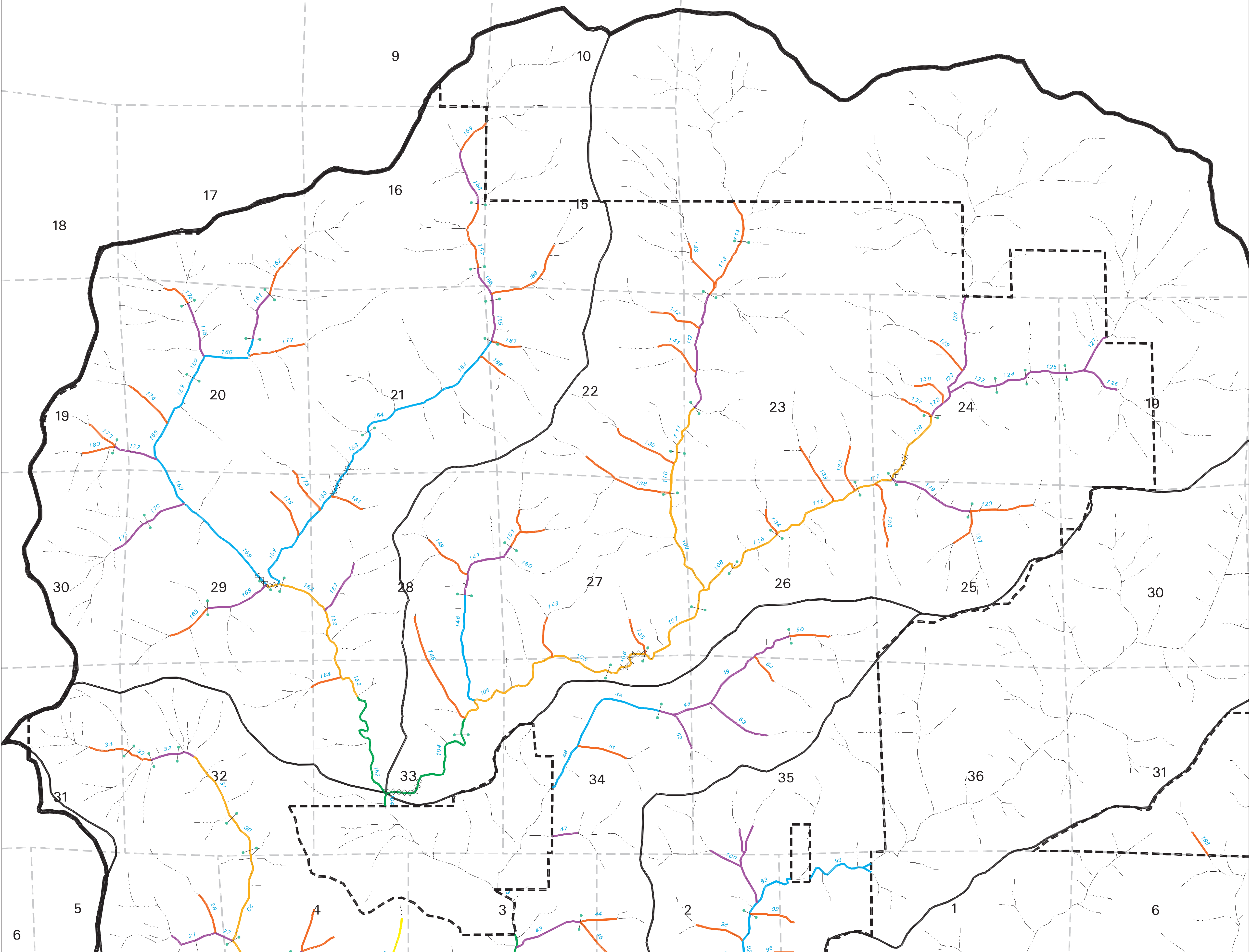
Large Woody Debris

Category	Description
Functional LWD (# pieces)	number of functional pieces LWD in active channel.
Functional LWD (#/100m)	number of functional pieces LWD/100 meters of active channel.
Key LWD (# pieces)	number of key LWD pieces in active channel.
Key LWD (#/100m)	number of key LWD/100 meters in active channel.
Functional LWD (# in bfull)	number of functional pieces LWD within bankfull channel.
Functional LWD (bf #/100m)	number of LWD/100 meters within bankfull channel.
Key LWD (# in bfull)	number of key LWD pieces in bankfull channel.
Key LWD (bf #/100m)	number of key LWD/100 meters in bankfull channel.
LWD Abundance	S=sparse, C=common, A=abundant
Percent Current/Relic Recruitment -	percentage of active or recently recruited LWD vs. LWD which is relic or not from a recently live tree (i.e. old growth logs, old stumps, etc.)
# of LWD Accumulations	number of LWD accumulations >3 pieces in size.

Pool Characteristics

Category	Description
Free	number of free formed pools in segment.
LWD Forced	number of LWD forced pools in segment.
Boulder Forced	number of boulder forced pools in segment.
Bank Forced	number of bank forced pools in segment.
Total # Pools	total number of pools in segment.
Pool Spacing	number of pools per bankfull width.

Shade Canopy %	percentage of shade over the channel.
Comments	general comments.



Noyo River Watershed Analysis Unit

Map E-1 Stream Channel Geomorphic Units and Segments

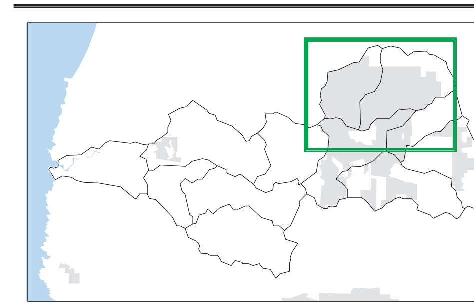
- Highly Entrenched Depositional River Segments Confined by Strath Terraces
- Moderately Entrenched Depoistional Channels within Strath Terraces and V-Shaped Canyons
- Slightly Entrenced Depositional Channels within Strath Terraces and U-Shaped Canyons
- Moderate Gradient (2-8%) Transport Segments of V-Shaped Canyons
- Response and Transport Segments of U-Shaped Canyons
- High Gradient (8-20%) Tansport Segments of V-Shaped Canyons
- Long Term Monitoring Sites

Flow Class

- Class I
- Class II
- Class III

- MRC Ownership
- WWAA Boundary
- Planning Watershed Boundary

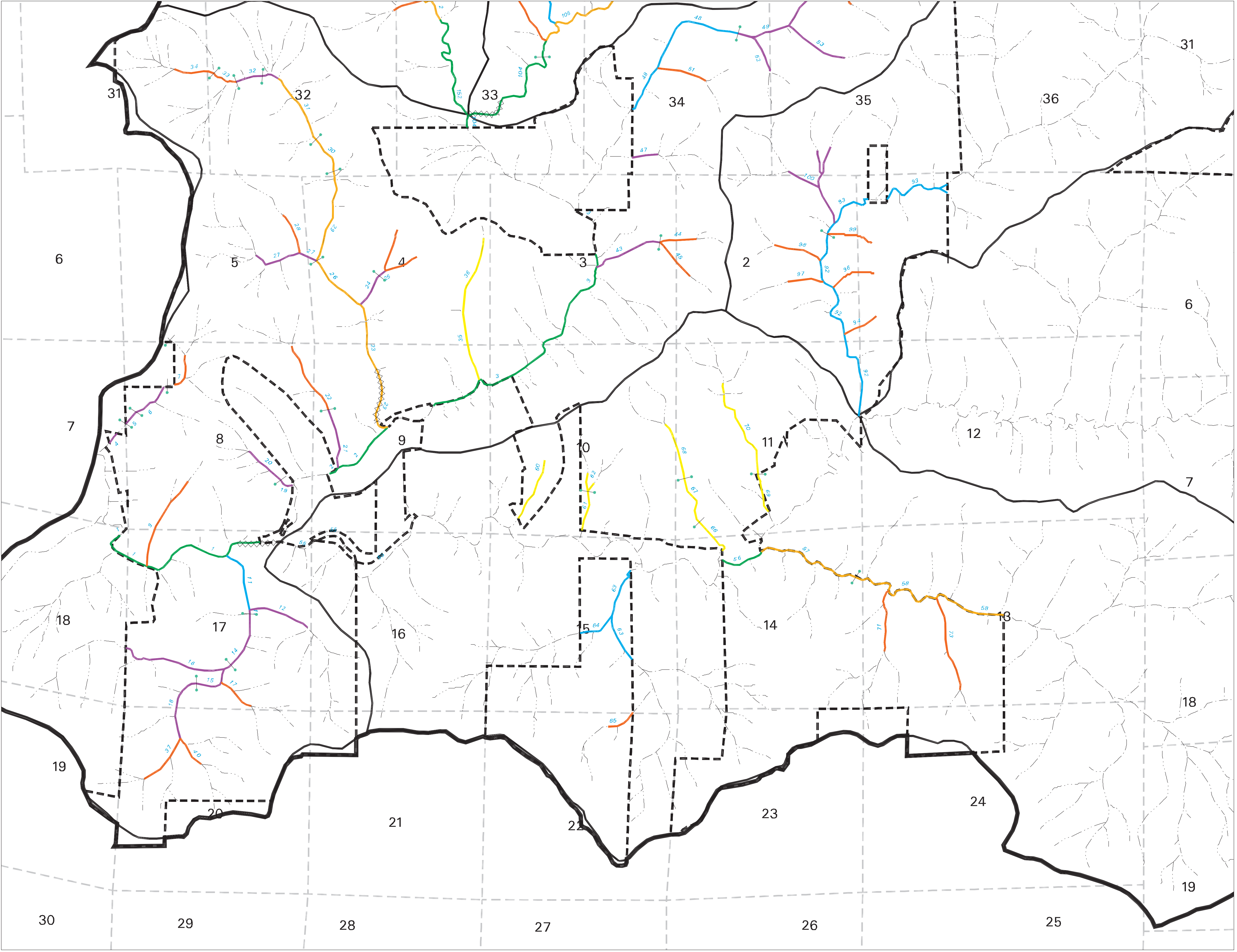
Sheet 1



0 1/2 1 Mile

September 22, 2000

Noyo River Watershed Analysis Unit



Map E-1 Stream Channel Geomorphic Units and Segments

- Highly Entrenched Depositional River Segments Confined by Strath Terraces
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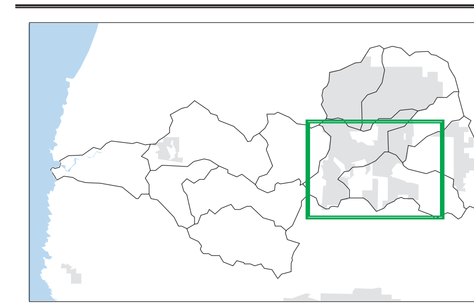
Sheet 2



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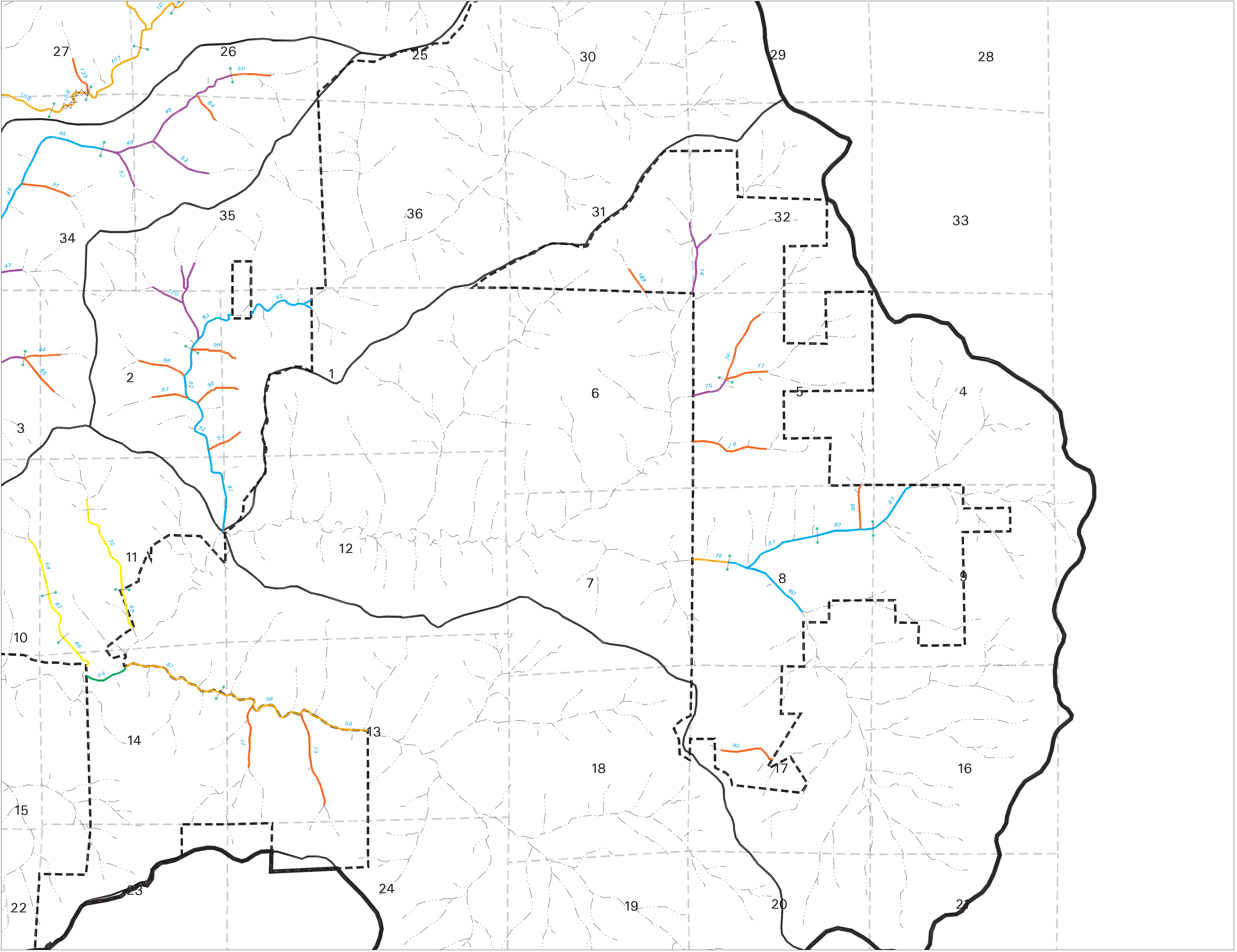


Noyo River Watershed Analysis Unit

Map E-1 Stream Channel Geomorphic Units and Segments

Highly Entrenched Depositional River Segments Confined by Strath Terraces

Moderately Entrenched Depoistional Channels within Strath Terraces and V-Shaped Canyons

Slightly Entrenced Depositional Channels within Strath Terraces and U-Shaped Canyons

Moderate Gradient (2-8%) Transport Segments of V-Shaped Canyons

Response and Transport Segments of U-Shaped Canyons

High Gradient (8-20%) Tansport Segments of V-Shaped Canyons

Long Term Monitoring Sites

Flow Class

Class I

Class II

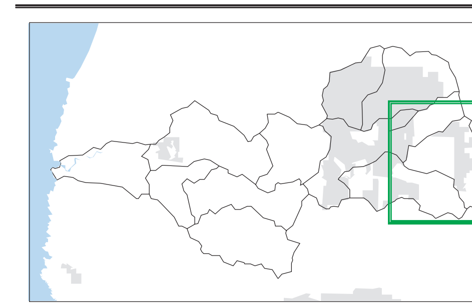
Class III

MRC Ownership

WWAA Boundary

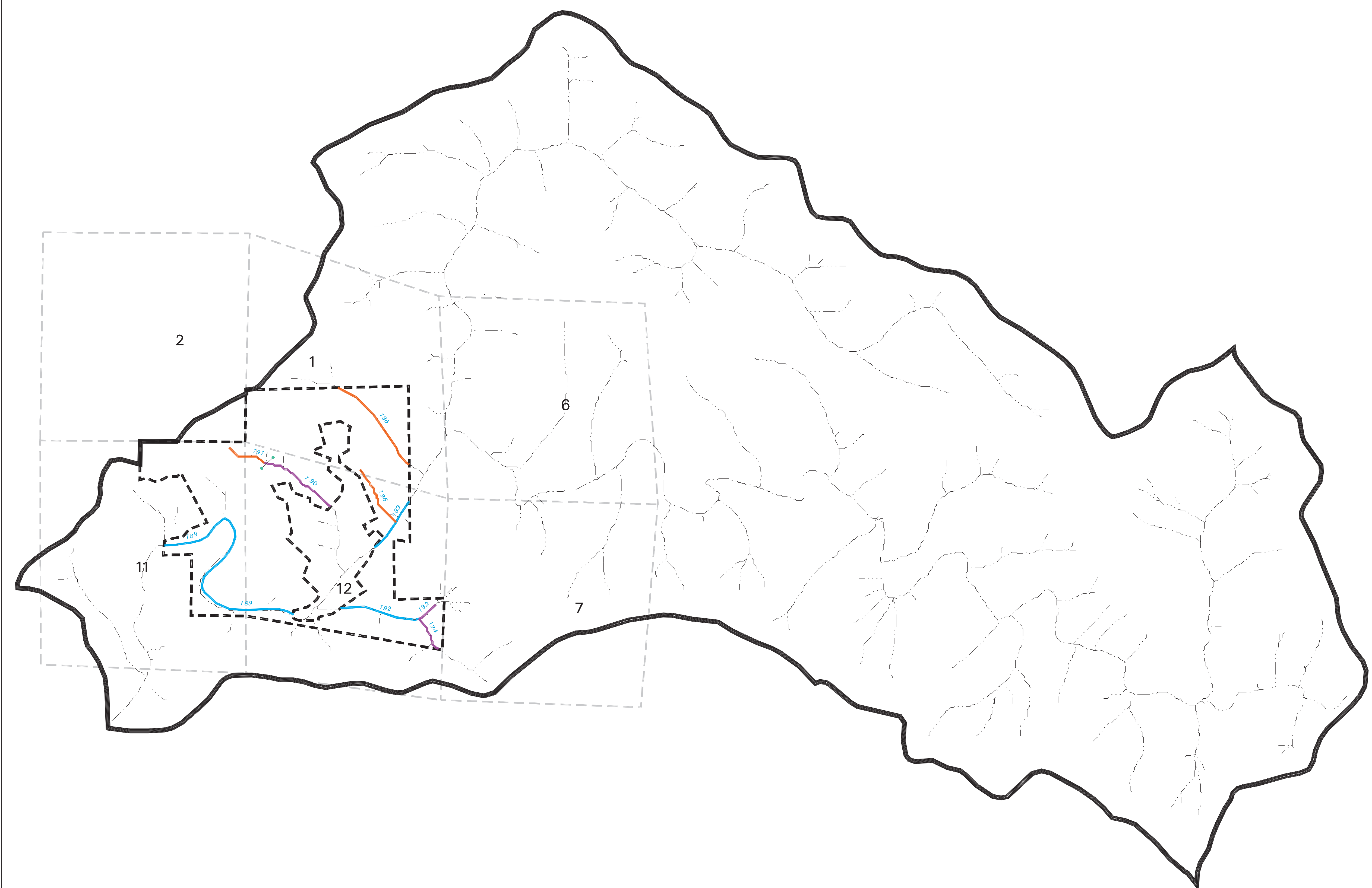
Planning Watershed Boundary

Sheet 3



0 1/2 1 Mile

September 22, 2000



Noyo River Watershed Analysis Unit

Map E-1 Stream Channel Geomorphic Units and Segments

Highly Entrenched Depositional River Segments Confined by Strath Terraces

Moderately Entrenched Depoistional Channels within Strath Terraces and V-Shaped Canyons

Slightly Entrenced Depositional Channels within Strath Terraces and U-Shaped Canyons

Moderate Gradient (2-8%) Transport Segments of V-Shaped Canyons

Response and Transport Segments of U-Shaped Canyons

High Gradient (8-20%) Tansport Segments of V-Shaped Canyons

Long Term Monitoring Sites

Flow Class

Class I

Class II

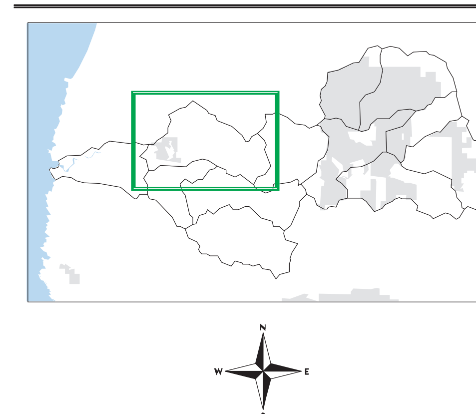
Class III

MRC Ownership

WWAA Boundary

Planning Watershed Boundary

Sheet 4



0 1/2 1 Mile

September 22, 2000

Geomorphic Unit I. Highly Entrenched Depositional River Segments Confined by Strath Terraces.

Includes Segments: Field verified - 1, 3, 56, 104, 152(partial)
Extrapolated - 2, 55

General Description:
River and stream channel segments in this unit flow in an entrenched gorge within strath terraces varying from 50 to 150 feet deep. These channels are highly confined within this entrenched gorge with no floodplain or channel migration capability. Channel gradients are low (<1 percent), but sediment transport capacity is high during high flows due to the highly confined channel keeping water energy directed with the entrenched gorge. The channel bed varies from boulder to cobble sized particles, with many areas bedrock dominated.

Associated Channel Types:
This unit primarily exhibits plane bed and pool/riffle morphology. The pool/riffle areas occur where the channel has some localized gradient shifts or meanders. The Rosgen (Rosgen, 1996) classification for these channels are F1, F2, and F3 depending on the channel bed composition, however C3 was observed once as well.

Fish Habitat Associations:
The highly confined channels of this units have a high sediment transport capacity during high flows, which flushes fine sediment, creating cleaner, high quality spawning gravel. This same high energy transport, in conjunction with a lack of wood, creates free-formed pools in which the energy of the water creates the scour associated with the pool. Typically, free-formed pools have low shelter complexity because they are not associated with bedrock or large wood and there is little refuge for fish. This unit provides little habitat for the over-wintering life stage of salmonids.

Conditions and Response Potential

Coarse Sediment: Moderate Response Potential
Coarse gravel accumulations are primarily in point and alternating gravel bars, with some medial bars. The gravel bar abundance is few to common. Currently the channel does not show evidence of either aggrading or degrading. However, there is evidence of some past aggradation in isolated areas of this unit. The highly confined water flow of this unit creates high coarse sediment transport capacity. However, based on evidence of past aggradation, if the coarse sediment supply is high then the bed could raise reducing channel complexity and habitat.

Fine Sediment: Moderate Response Potential

High accumulations of fine sediment were not observed in this unit. Fine sediment is restricted to the top of gravel bars, accumulated in the bed of plane bed reaches, along pool margins, and in some pools. However, the fine sediment observations are of only sparse to moderate accumulations. The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, when there is a high fine sediment supply in transport, accumulations of fine sediment can occur in this unit.

Large Woody Debris: Moderate Response Potential

Large woody debris is sparse in this unit. Little LWD is available for stream habitat development or cover. The high flows which are confined within the terrace gorges of this unit require very large LWD pieces or debris jams to keep the LWD in place. Very large LWD is recruited into channels infrequently due to the long growing times of streamside trees. However, LWD in this unit is important because the channels in this unit would gain greater fish habitat diversity with increased large woody debris.

Geomorphic Unit II. Moderately Entrenched Depositional Channels within Strath Terraces and V-shaped Canyons.

Includes Segments: Field verified - 23, 57, 106, 118, 152 (partial)
Extrapolated - 26, 29, 30, 31, 58, 79, 105, 107, 108, 109, 110, 111, 115, 116, 117

General Description:
River and stream channel flow in this unit alternates within entrenched gorges in strath terraces to adjacent to steep canyon side slopes with occasional stream side terraces and floodplains. These channels are highly confined when in a entrenched gorge with no floodplain or channel migration capability, yet only moderately confined to unconfined where the side slopes of this unit are less entrenched and a floodplain is developed. Channel gradients are low (1-4 percent), but sediment transport capacity is high during high flows due to the high to moderately confined channel keeping water energy directed with the stream channel. The channel bed varies from cobble to gravel sized particles, with some bedrock sections.

Associated Channel Types:
This unit primarily exhibits pool/riffle, forced pool/riffle and plane bed morphology. The Rosgen (Rosgen, 1996) classification for these channels varies between B2, B3, C2, F3, G3 and G1 depending on the channel bed composition and adjacent bank configuration.

Fish Habitat Associations:
This unit is characterized by large substrate that provides an element of roughness to the stream. Larger sized cobbles break up the flow of water creating velocity breaks and bubble curtains. Velocity breaks are located directly behind (downstream) cobble and boulders and provide a resting place for fish. The white water or bubble curtains that are created by larger, exposed substrate, are considered a valuable source of shelter for fish. This unit has low amounts of large woody debris, however due to the entrenched V-shaped canyons, wood recruitment would have a positive effect on the quality of in-stream habitat by making the shelter associated with pools more complex.

Conditions and Response Potential

Coarse Sediment: Moderate Response Potential
Coarse sediment accumulations are found in point, alternate and medial gravel bars. The gravel bar abundance is few to common. Currently the channel does not show evidence of either aggrading or degrading. However, there is evidence of some past aggradation and degradation in areas of this unit. In confined areas of this unit coarse sediment transport capacity is high due to concentrated water energy. In less confined sections the coarse sediment transport capacity is less, and greater accumulations of coarse sediment could occur.

Fine Sediment: Moderate Response Potential

High accumulations of fine sediment were not observed in this unit. Fine sediment accumulations varied from the top of gravel bars, along pool margins, in some pools, and in the bed of some riffle reaches. Fine sediment are in moderate accumulations, with occasional high accumulations. The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, when there is a high fine sediment supply in transport, accumulations of fine sediment can occur in this unit.

Large Woody Debris: High Response Potential

Large woody debris is sparse in this unit. LWD is currently providing minimal function for stream habitat development or cover. Where the LWD loadings are higher in this channel greater pool development was observed. The forced pool/riffle morphology which was occasionally present in this unit also suggests a sensitivity to increased LWD loading.

Geomorphic Unit III. Slightly Entrenched Depositional Channels within Strath Terraces and "U"-shaped Canyons.

Includes Segments: Field verified - 48, 63, 64, 80, 92, 153, 159
Extrapolated - 11, 81, 82, 83, 93, 146, 154, 160, 189, 192

General Description:
Stream channel segments in this unit meander in slightly entrenched streamside terraces. Typically the entrenchment varies from 3 to 10 feet in depth. These channels vary from unconfined with discontinuous to continuous floodplains to confined with discontinuous floodplains. In very high flows water has some opportunities to go over the channel banks and access a floodplain in the less confined sections. Channel gradients are low (1-4 percent), but sediment transport capacity is high during high flows due to the entrenched channels keeping water energy directed with the stream channel. The channel bed varies from cobble to gravel sized particles, with some bedrock sections.

Associated Channel Types:
This unit is primarily exhibits pool/riffle and plane bed morphology. The Rosgen (Rosgen, 1996) classification for these channels is primarily F3, but B3, C3, and F4 were observed depending primarily on adjacent bank and side slope configuration.

Fish Habitat Associations:
The channels of this unit meander through streamside terraces which downcut through terraces and under-cut the banks, creating more sheltered habitat. These undercut banks provide refuge and shelter for fish, but can also increase fine sediment loading to spawning gravels. The meandering channel is also able to access the floodplain during high flows, which can aid in recruiting wood to the stream and provide sediment deposition outside of the channel. Additionally, the narrow channel enables debris jams to more easily form, which can increase pool depth, frequency, and shelter for fish.

Conditions and Response Potential

Coarse Sediment: High Response Potential
Accumulations of coarse sediment are found in point, alternate, medial and LWD forced gravel bars. The gravel bar abundance is few to common with some abundant accumulations. Currently the channel does show some evidence of down-cutting and occasional evidence of aggradation in response to coarse sediment fluctuations. There is evidence of past aggradation in this unit as well. In less confined sections with LWD accumulations the coarse sediment transport capacity is less and greater accumulations of coarse sediment occur.

Fine Sediment: Moderate Response Potential

High accumulations of fine sediment were not observed in this unit. Fine sediment accumulations varied from to the top of gravel bars, along pool margins, in some pools, and in the bed of some riffle reaches. Fine sediment observations were of only sparse to moderate accumulations. The discontinuous floodplain promotes high fine sediment transport due to concentrated stream power within slightly entrenched channels, while promoting deposition of fine sediments when high flows do access the floodplain.

Large Woody Debris: High Response Potential

Large woody debris is sparse to common to occasionally abundant in this unit. LWD is functional for stream habitat development or cover where LWD loading is high. Where the LWD loadings are higher in this channel greater pool development and pool depths were observed. LWD in this unit was observed to force storage of coarse sediments creating a more complex channel morphology. The narrow channel enables LWD to lodge and debris jams to more easily form.

Geomorphic Unit IV. Moderate Gradient (2-8%) Transport Segments of "V"-Shaped Canyons.

Includes Segments: Field verified - 112, 119, 156, 161
Extrapolated - 4, 5, 6, 12, 14, 15, 16, 18, 19, 20, 21, 24, 27, 32, 35, 36, 43, 47, 49, 52, 53, 66, 67, 68, 74, 75, 100, 122, 123, 124, 125, 126, 127, 147, 155, 161, 167, 168, 170, 171, 172, 175, 190, 193, 194

General Description:
Stream channel segments in this unit are confined within canyons with steep side slopes. Typically valley widths are between 1.5 and 3 bankfull channel widths. This valley width is sufficient to allow some terrace formation and channel meandering. The channel segments in this unit are near the transition between deposition and transport channels. Due to the moderate gradient (2-8 percent) of the channels, they are responsive to aggradation and degradation from changes in the stream sediment supply. The stream bed of these channels varies from gravel to boulder sized particles. The terraces in this unit appear to be created from large episodic sediment loads such as frequent mass wasting. The gradient of the stream is high enough that stream segments in this unit easily downcut through the terrace deposits.

Associated Channel Types:
This unit primarily exhibits forced pool/riffle and step pool morphology. The Rosgen (Rosgen, 1996) classification for these channels varies between A2, A3, B2, G3, and G4 depending primarily on adjacent bank configuration.

Fish Habitat Associations:
The steeper gradient segments of this unit typically forms step-pool and forced pool-riffle habitat. The step-pools are typically boulder formed which provides pool depth, substrate refuge, rearing, and over-wintering habitat. Spawning areas in this unit are infrequent, due to the lack of accumulations of gravel sized particles.

Conditions and Response Potential

Coarse Sediment: High Response Potential
Accumulations of coarse sediment are found in alternate and LWD forced gravel bars. The gravel bar abundance is few to common with some abundant accumulations. Currently the channels show evidence of severe down-cutting and occasional evidence of aggradation in response to coarse sediment fluctuations. There is evidence of past aggradation and degradation in this unit as well.

Fine Sediment: Moderate Response Potential

Accumulations of fine sediment were observed in this unit. Fine sediment accumulations varied from sparse to high primarily on the top of gravel bars, but also in isolated pockets in pools. The discontinuous floodplain and moderate slope gradient promotes high fine sediment transport due to concentrated stream power within confined channels.

Large Woody Debris: Moderate Response Potential

LWD in this unit was observed to force storage of coarse sediments creating a more complex channel morphology. However, many times the LWD loading was very high yet pool spacing or formation was not improved. In channels where down-cutting was observed LWD was not observed improving the channel degradation. In channels with aggradation the LWD did assist in sediment storage.

Geomorphic Unit V. Response and Tranpsort Segments of "U"-Shaped Canyons.

Includes Segments: Field observed - 69
Extrapolated - 35, 36, 60, 61, 62, 70

General Description:
This unit is primarily created by the "U"-shaped valley bottom the channels flow through. Alluvial and some colluvial deposits create canyons which have little surface water flow, therefore little stream channel morphology influences. Often these canyons do not transport their sediment supply to down-slope streams or rivers due to the lack of surface water flow, particularly at the outlet of the canyons at the strath terraces along the Noyo River.

Associated Channel Types:
This typically does not have pronounced surface water flow. Often small channels are found within wet bog-like areas, however, surface flow is low.

Fish Habitat Associations:
No fish habitat is associated with this unit.

Conditions and Response Potential

Coarse and Fine Sediment: Low Response Potential
Inputs of coarse sediment have likely created the "U"-shaped morphology of the canyons in this unit. This has created a porous substrate providing predominantly sub-surface flow. With little surface flow there is little sediment transport, and little influence by coarse or fine sediments.

Large Woody Debris: Low Response Potential
LWD has little influence on this unit due to low surface water flow and the infrequent connection of these channels to down-slope streams or rivers.

Geomorphic Unit VI. High Gradient (8-20%) Transport Segments of V-Shaped Canyons.

Includes Segments: Field observed - 143
Extrapolated - 7, 9, 17, 22, 25, 28, 33, 34, 37, 40, 44, 45, 50, 51, 54, 65, 71, 73, 76, 77, 78, 88, 90, 94, 96, 97, 98, 99, 113, 114, 120, 121, 128, 129, 130, 131, 132, 133, 134, 135, 138, 139, 141, 142, 145, 148, 149, 150, 151, 157, 158, 162, 164, 169, 173, 174, 176, 177, 178, 179, 181, 186, 187, 188, 189, 191, 195, 196

General Description:
Channel segments in this unit are high gradient transport reaches from 8-20% with high sediment transport capacity. The channel segments in this unit typically flow through tightly confined, steep-sided, V-shaped canyons. These are typically zones of scour during high flows or debris flows. Stream substrate is typically from cobble to large boulders.

Associated Channel Types:
This unit varies it morphology from step pool to cascades with some occasional waterfalls. The cascades and waterfalls occur in the steepest segments of this unit. The Rosgen (Rosgen, 1996) classification for these channels varies between A2, A3, and AA2, AA3 depending on channel gradient and substrate composition.

Fish Habitat Associations:
The high gradient channels of this unit prevents anadromous coho from reaching these areas. Most likely, fish associated with this unit are resident rainbow trout. Steelhead trout are possible, but unlikely in the higher, 12% to 20% gradient areas.

Conditions and Response Potential

Coarse Sediment: Low Response Potential
The unit has very few terraces, bars or storage sites. The roughness of the channels creates varied coarse sediment transport capacity. Large woody debris and large boulders can create some sediment storage.

Fine Sediment: Low Response Potential
Fine sediment accumulations in this unit range from sparse to moderate. Sediment transport capacity is high in these reaches allowing most fine sediment to be transported out of this unit.

Large Woody Debris: Moderate Response Potential
Large woody debris is sparse to abundant in this unit. Large woody debris provides some sediment storage and roughness elements in this unit. The cascade and step pool morphology could be affected by an increase or decrease in LWD.

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Platts, W., W. Megahan, and G. W. Minshall. Methods for evaluating stream, riparian, and biotic conditions. USDA-Forest Service. Intermountain Forest and Range Experiment Station. Gen. Tech. Rep. INT-138. Ogden, UT. 70 p.

Terhune. L. D. B. 1958. The Mark IV groundwater standpipe for measuring seepage through salmon spawning gravel. Fish Res. Bd. Canada, 15(5), pp. 1027-1063.

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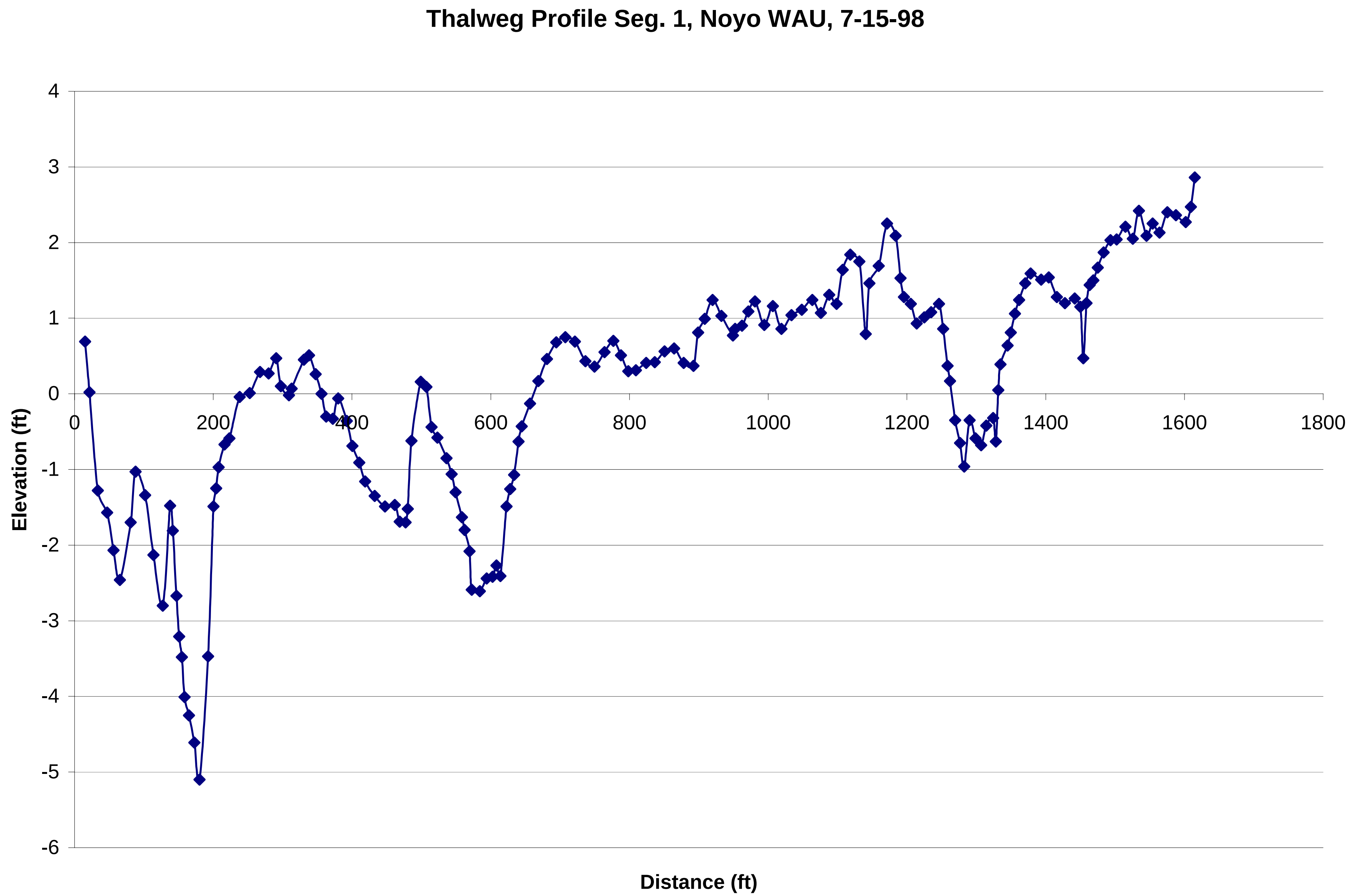
Appendix E

Stream Channel Condition Module



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-4
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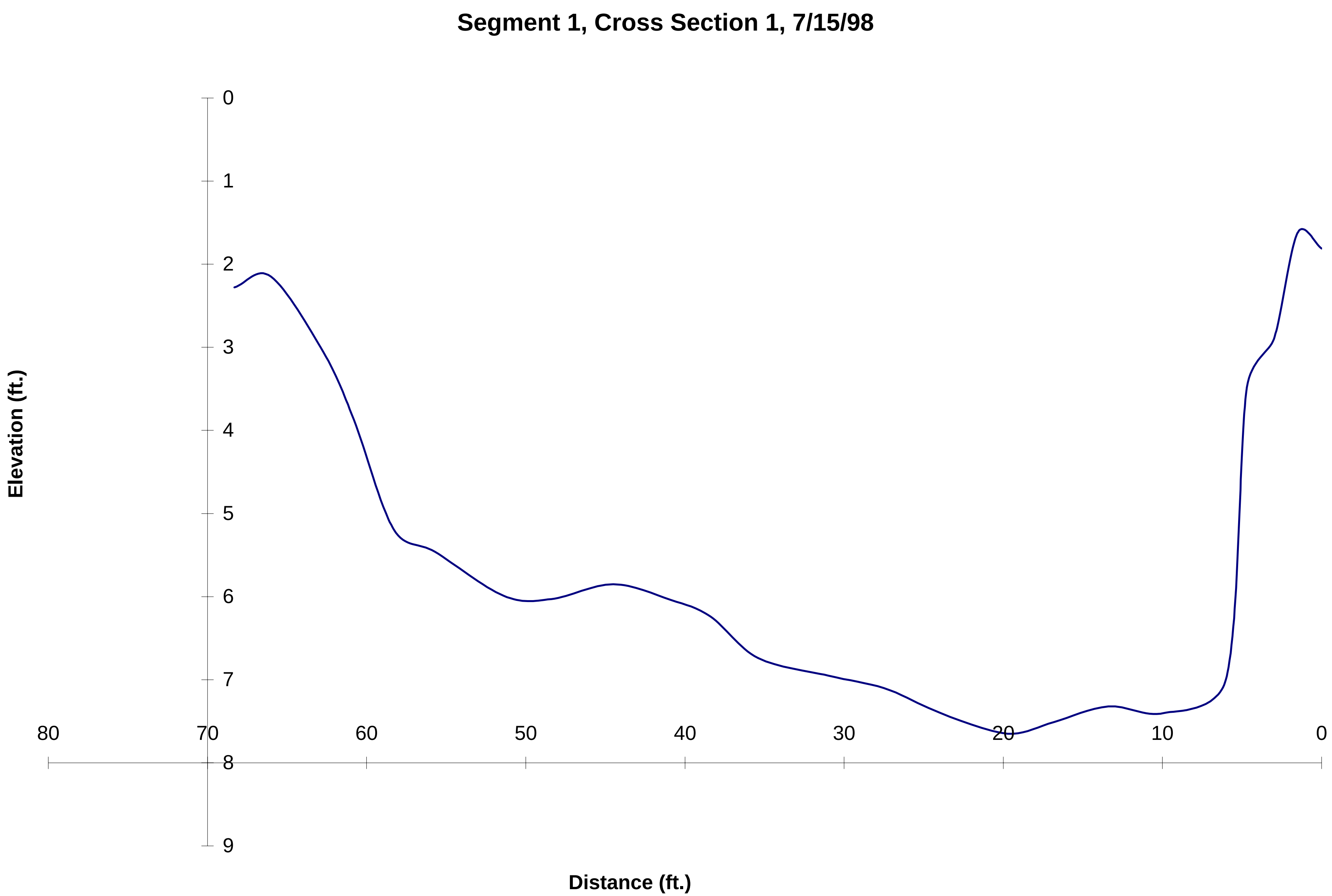
600
800
1000
1200
1400
1600
1800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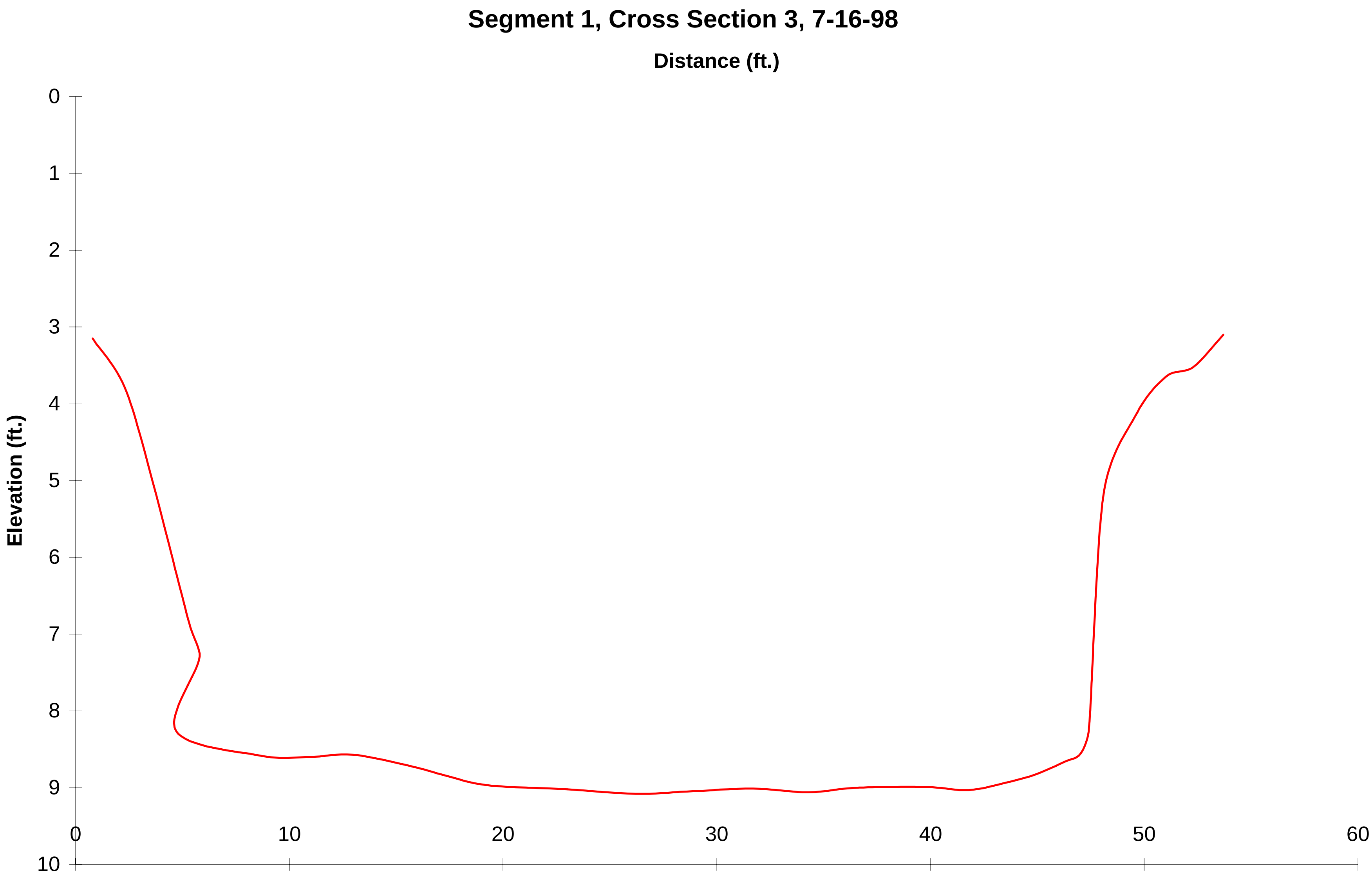
Distance (ft.)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30
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50
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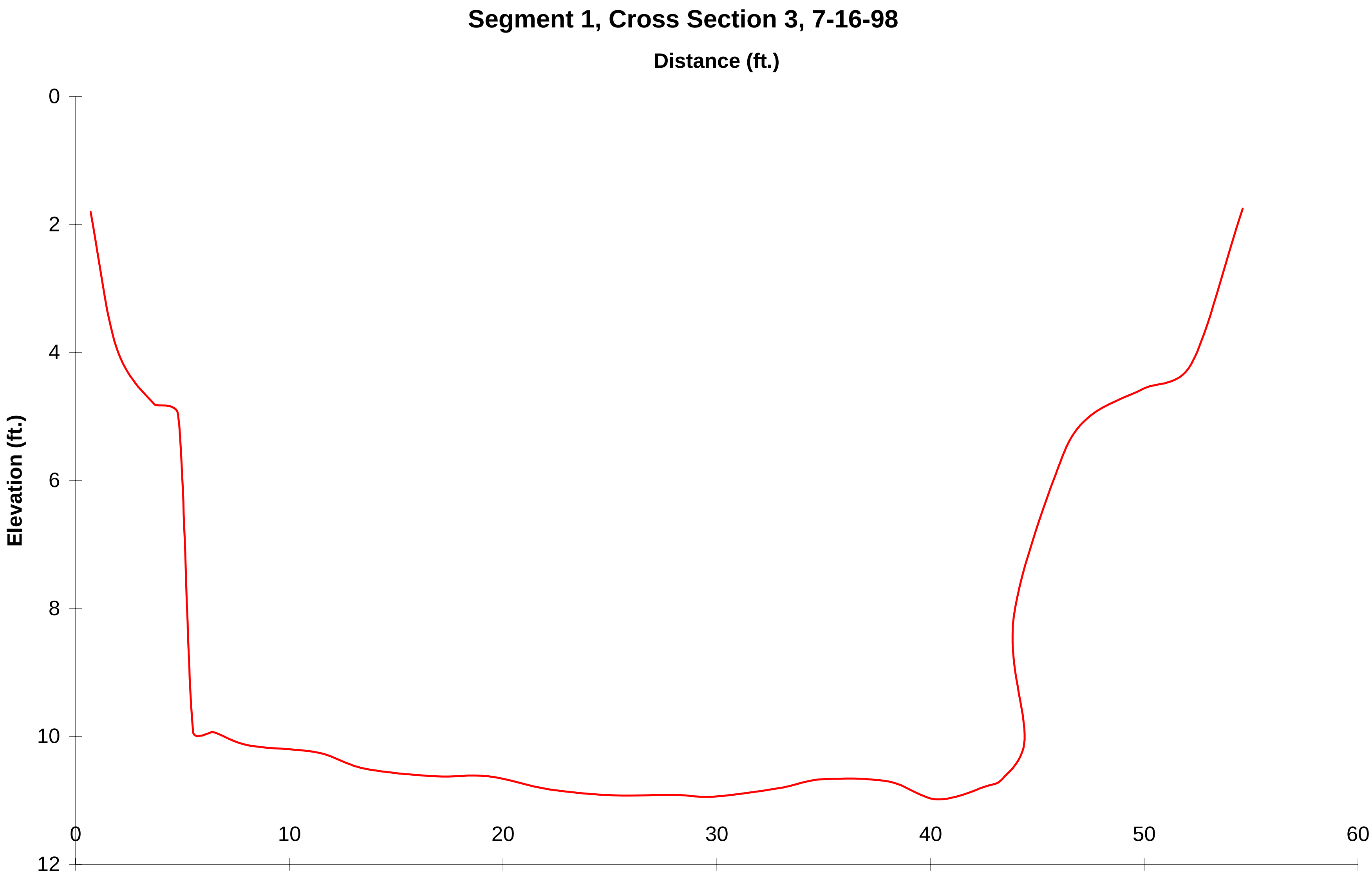
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30
40
50
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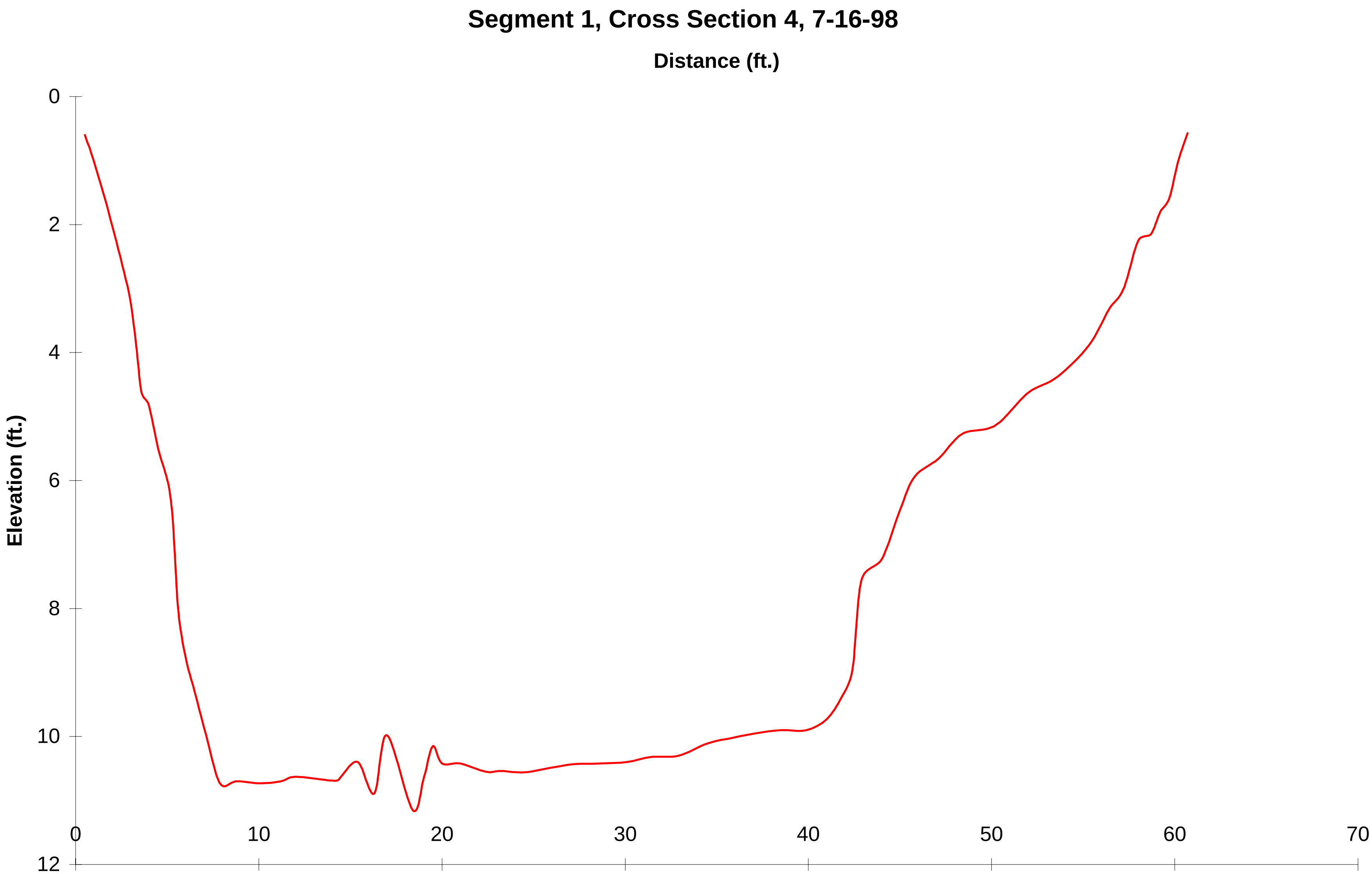
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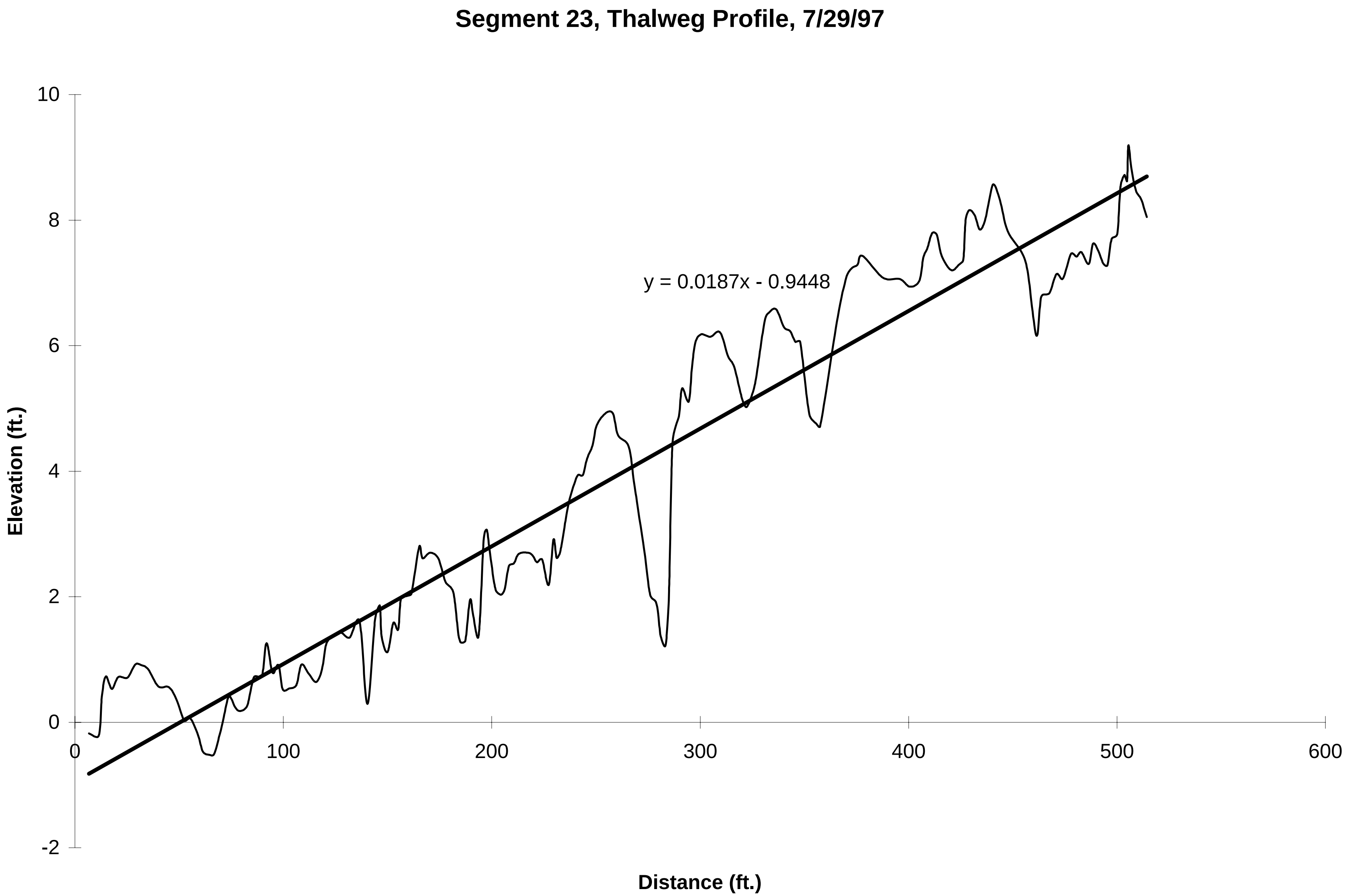
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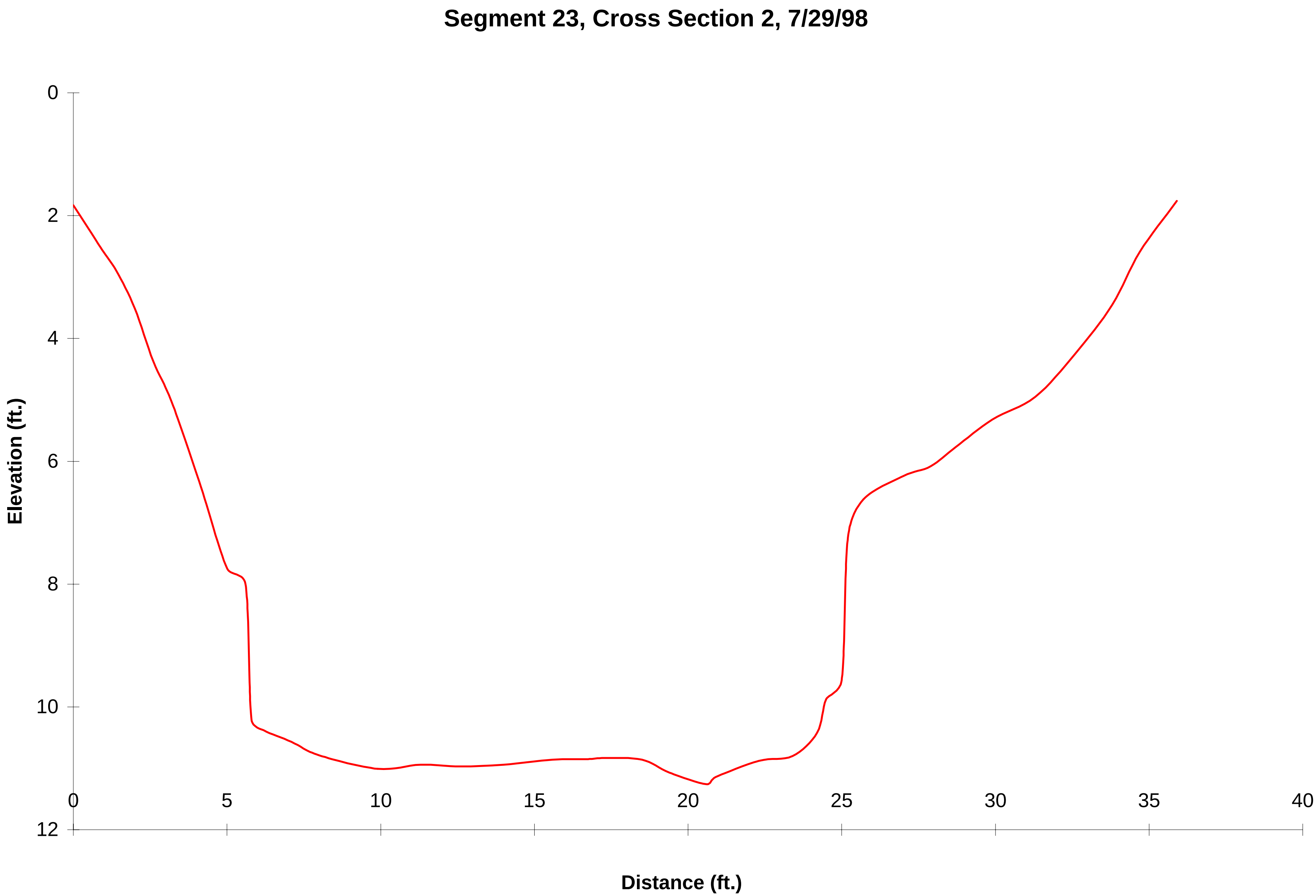
400
500
600
Distance (ft.)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35
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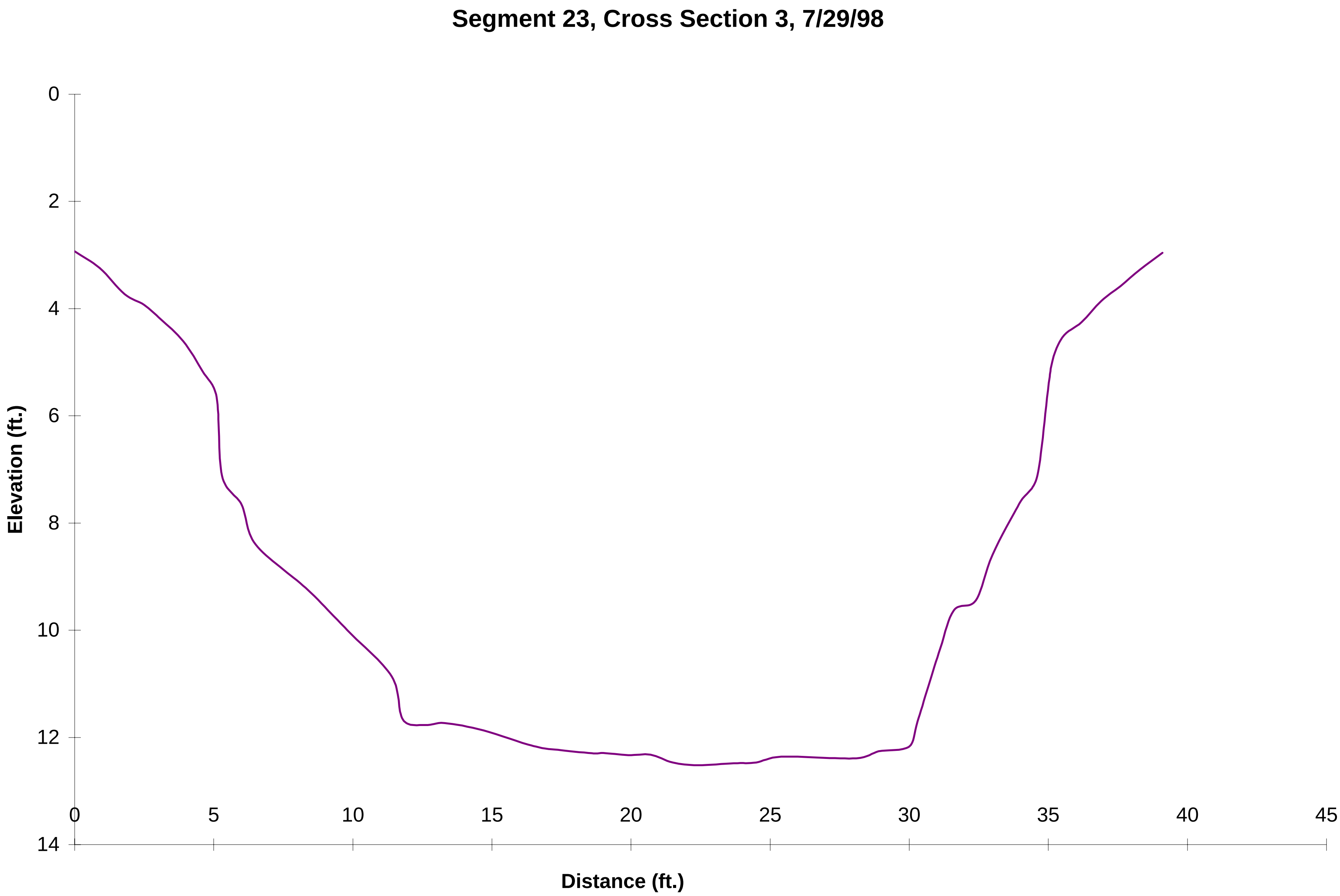
Distance (ft.)



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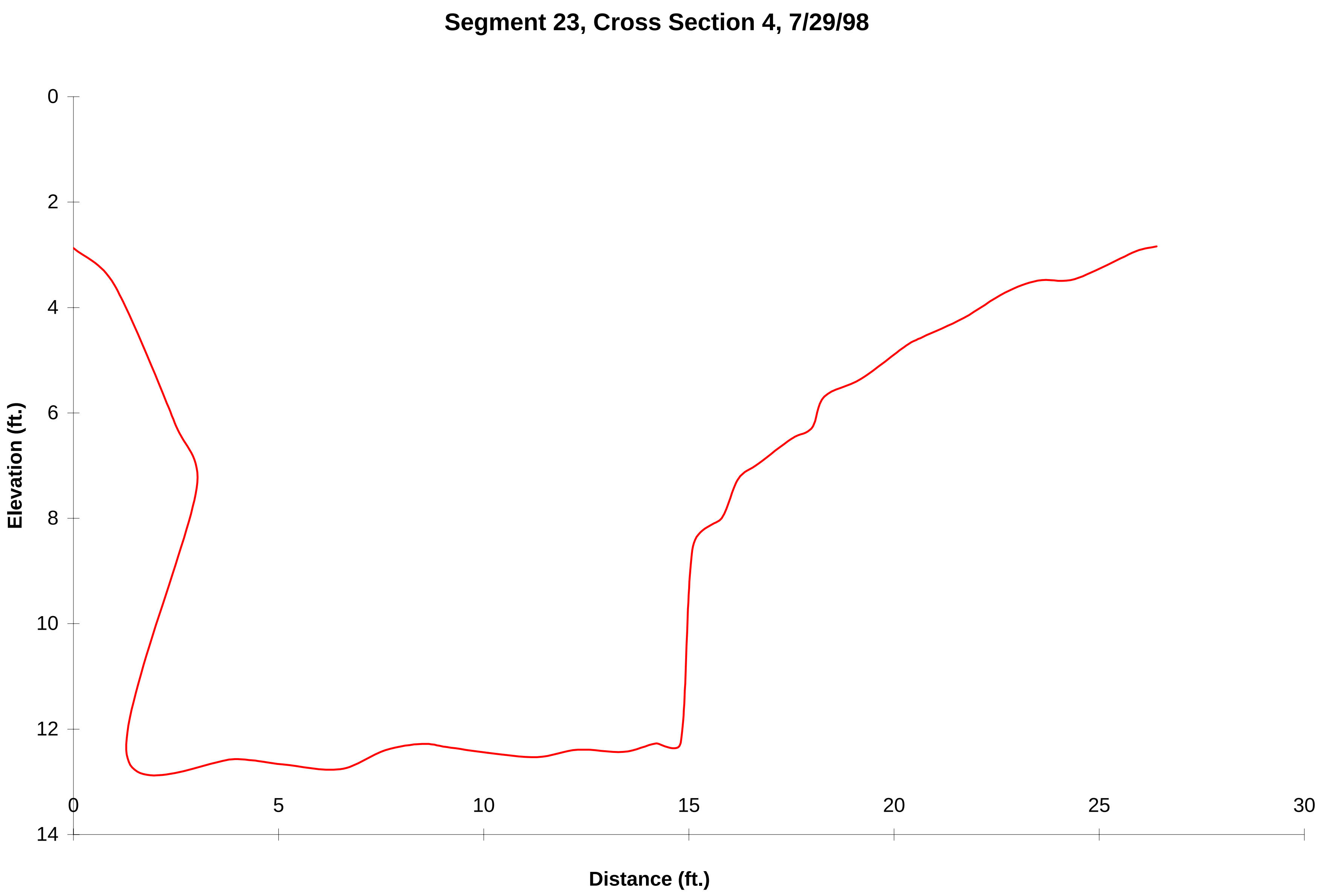
30
35
40
45
Distance (ft.)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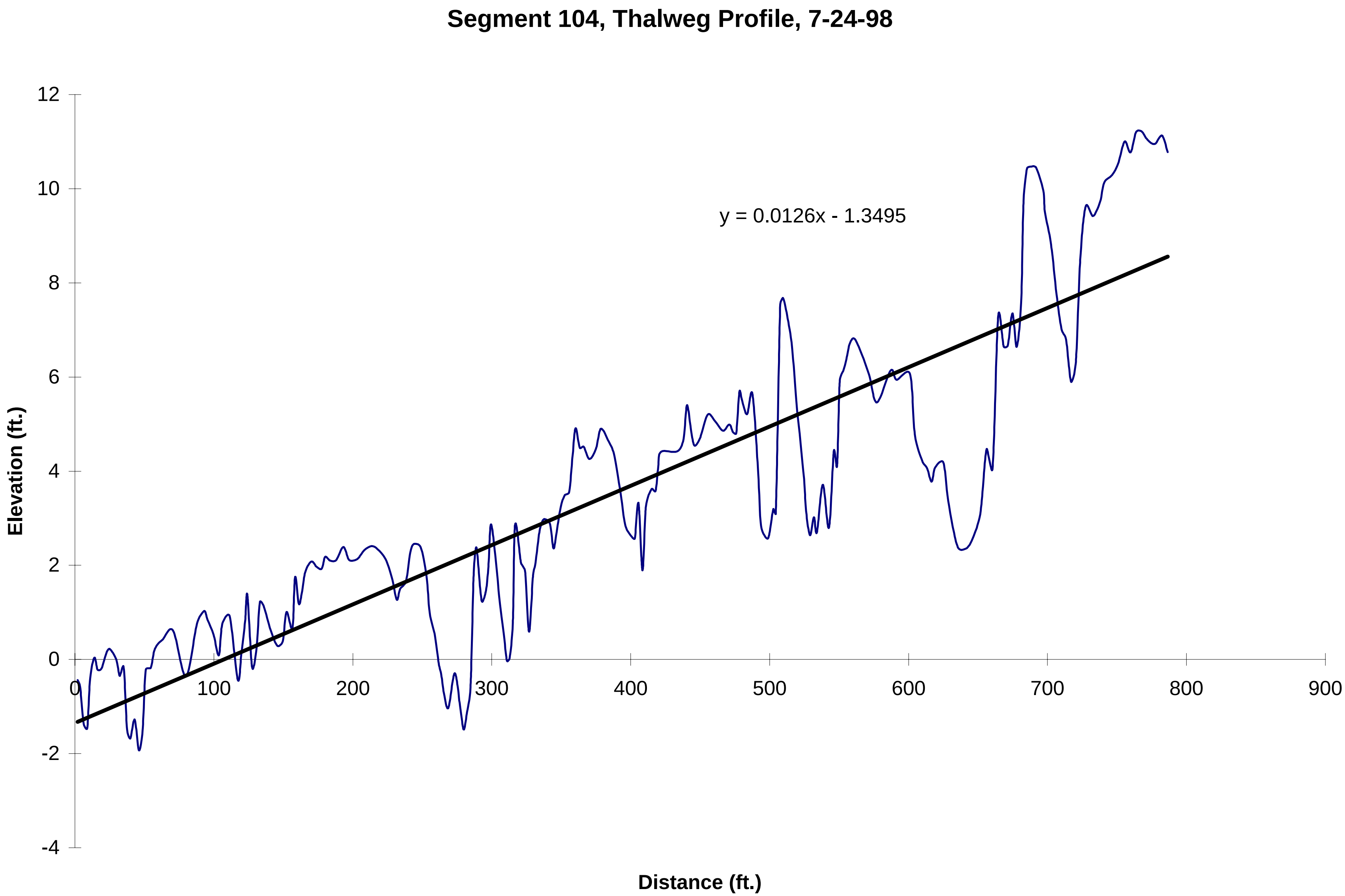
25
30
Distance (ft.)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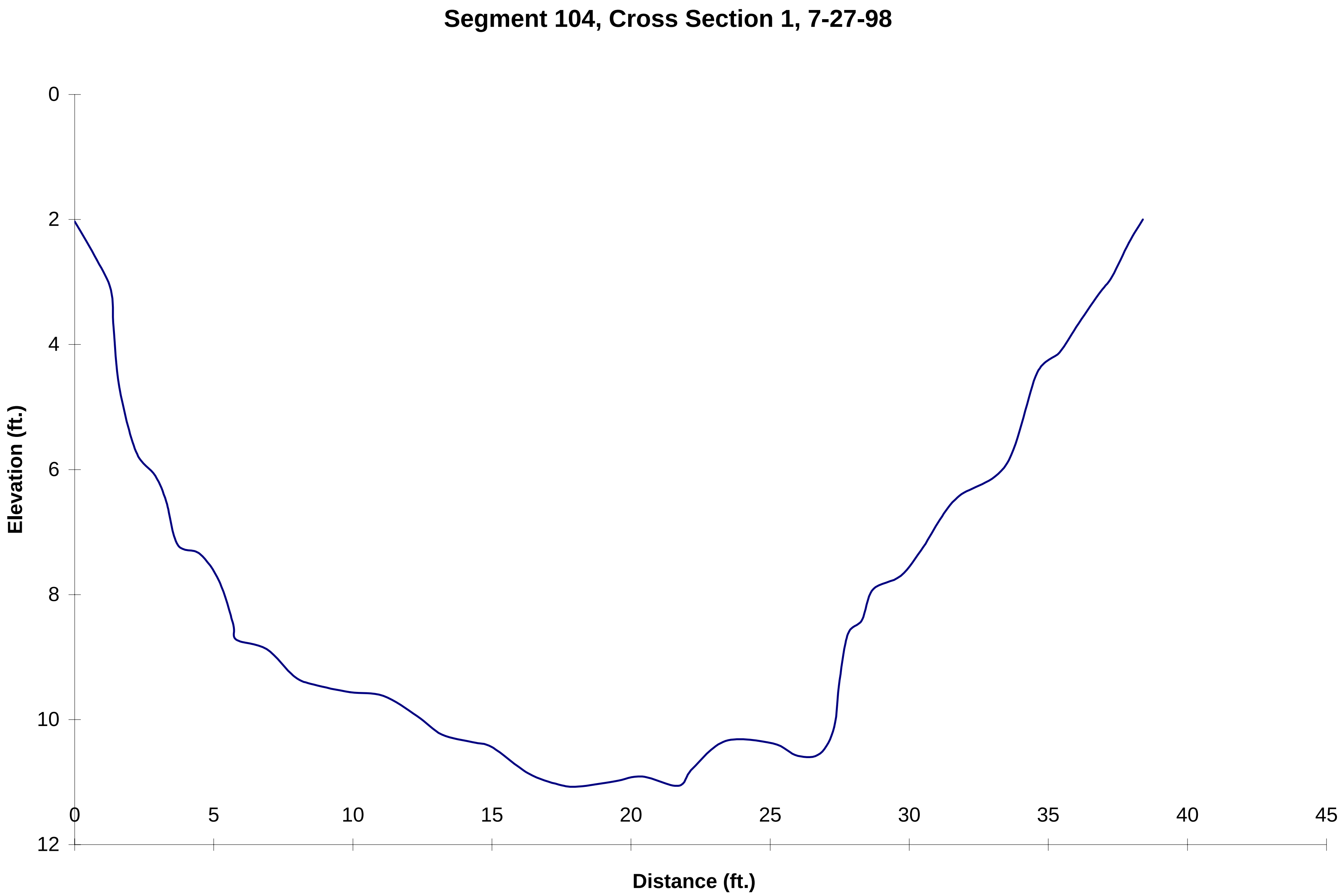
700
800
900



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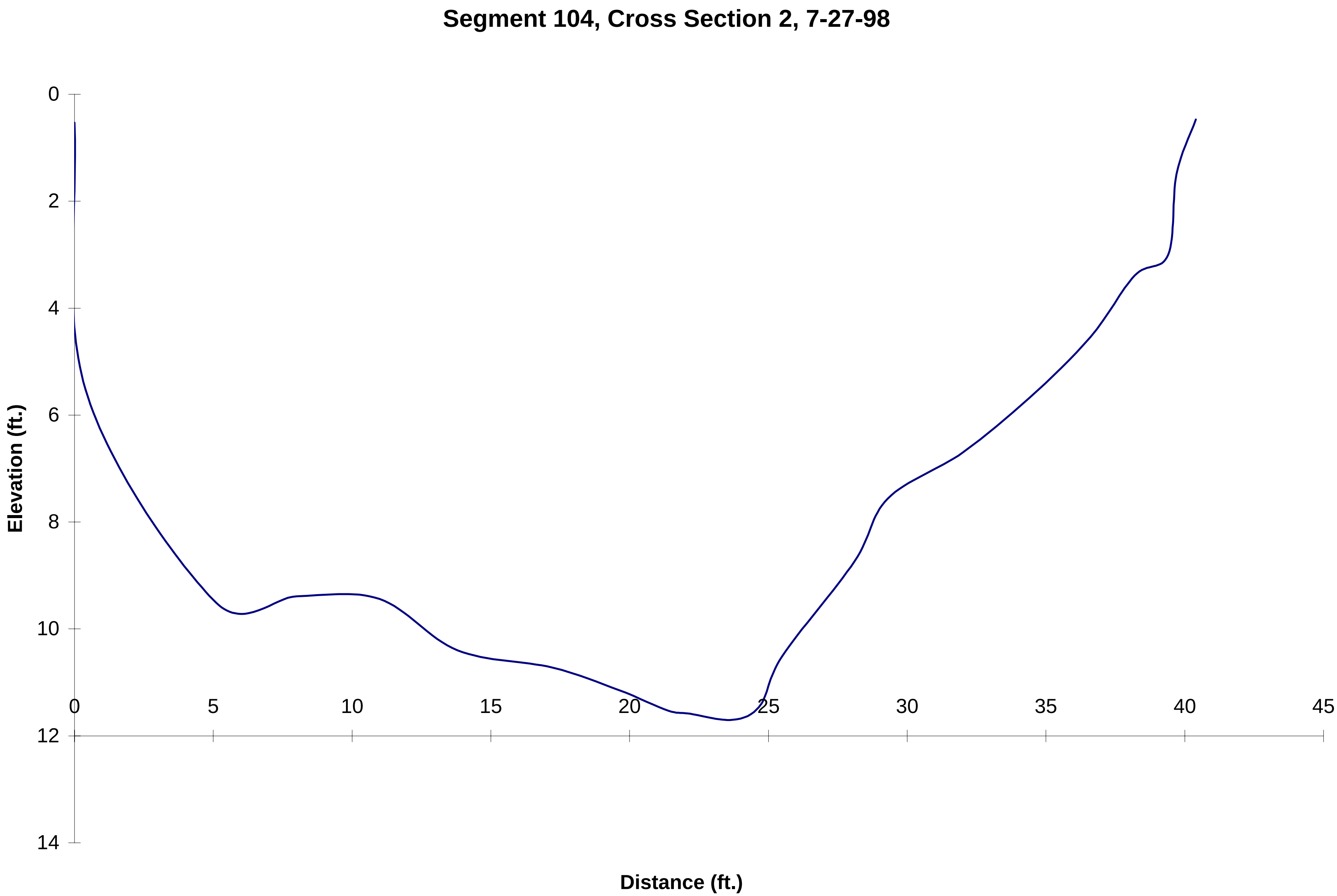
35
40
45
Distance (ft.)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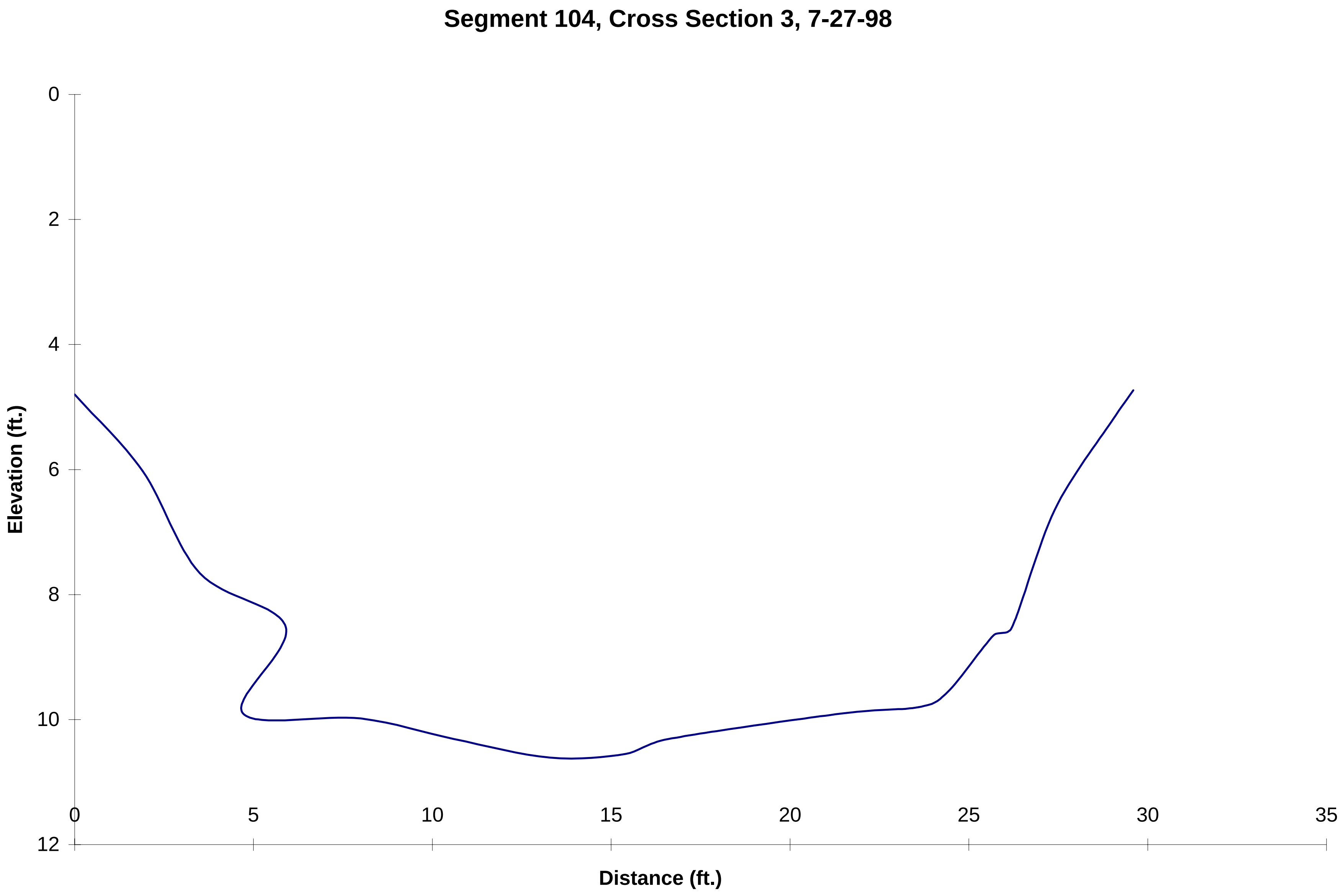
45
Distance (ft.)



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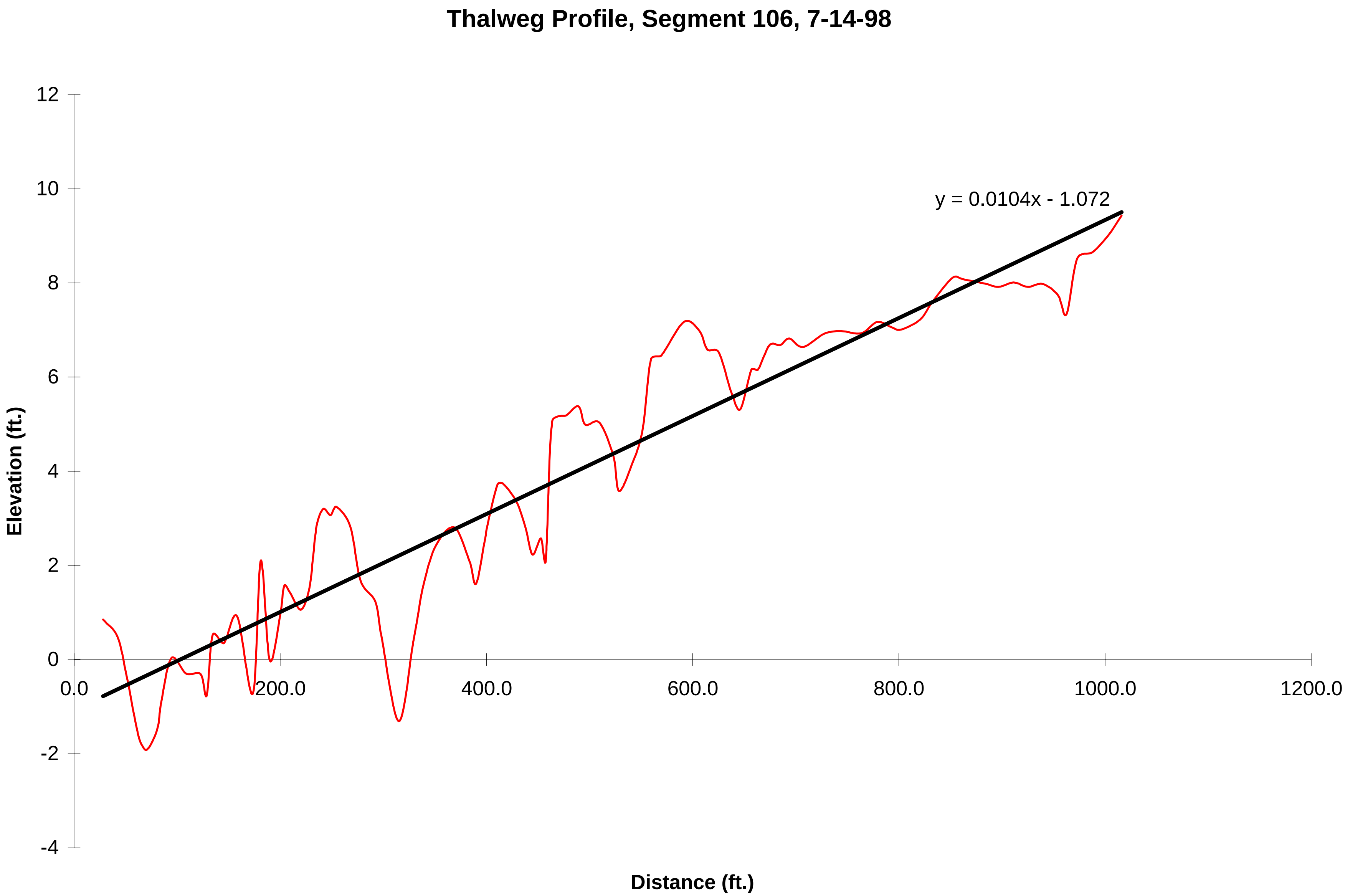
35
Distance (ft.)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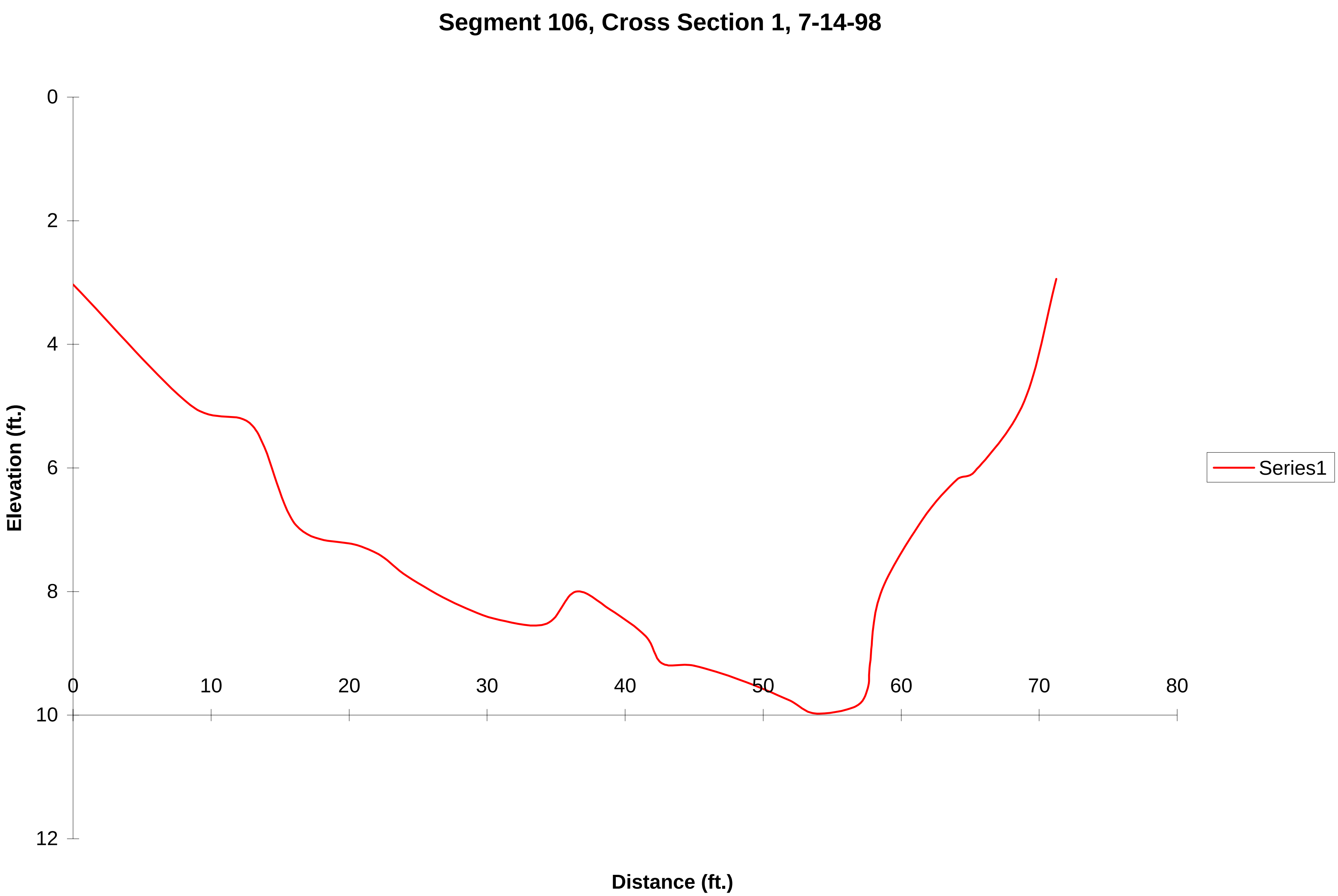
1200.0
Distance (ft.)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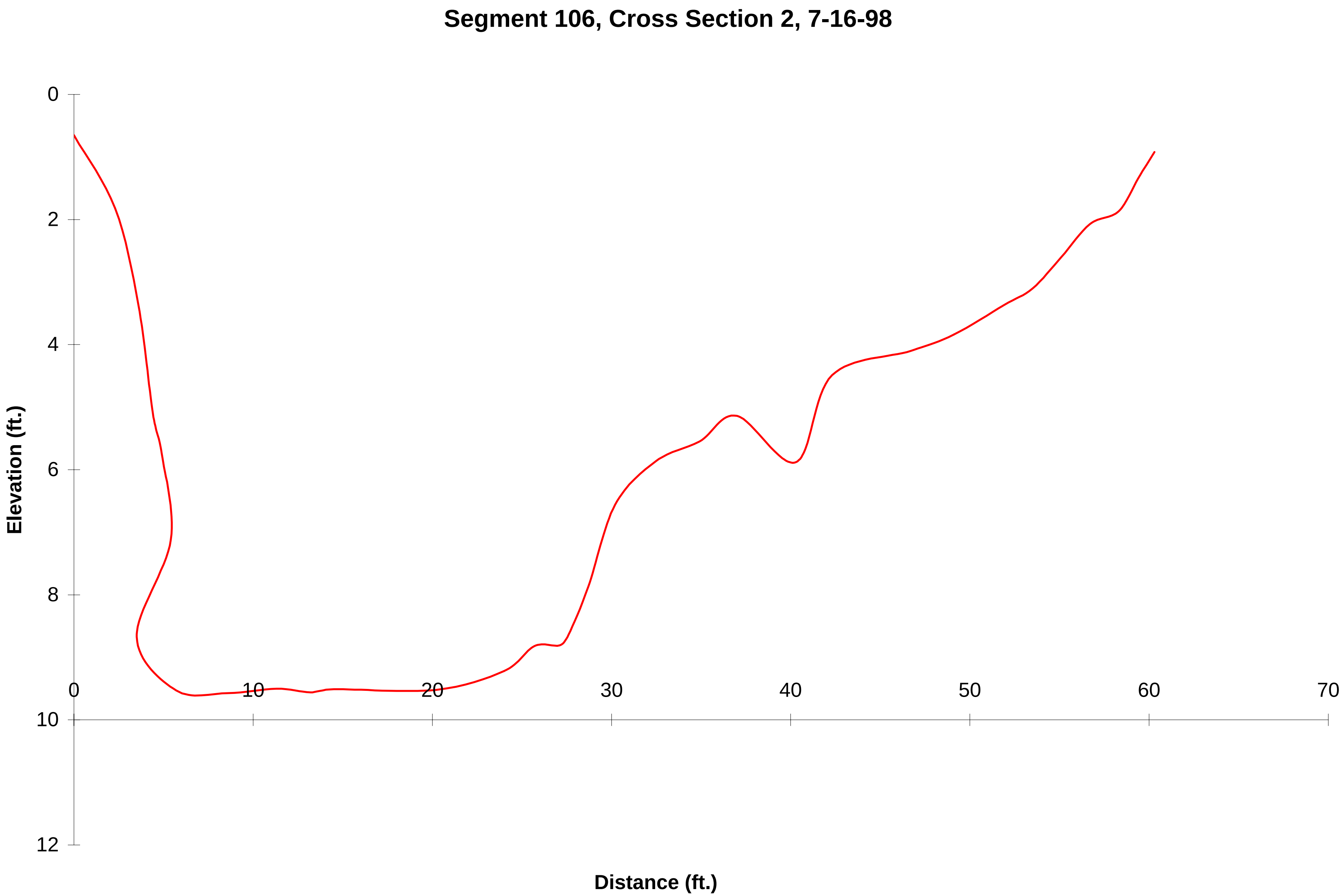
80
Distance (ft.)
Series1



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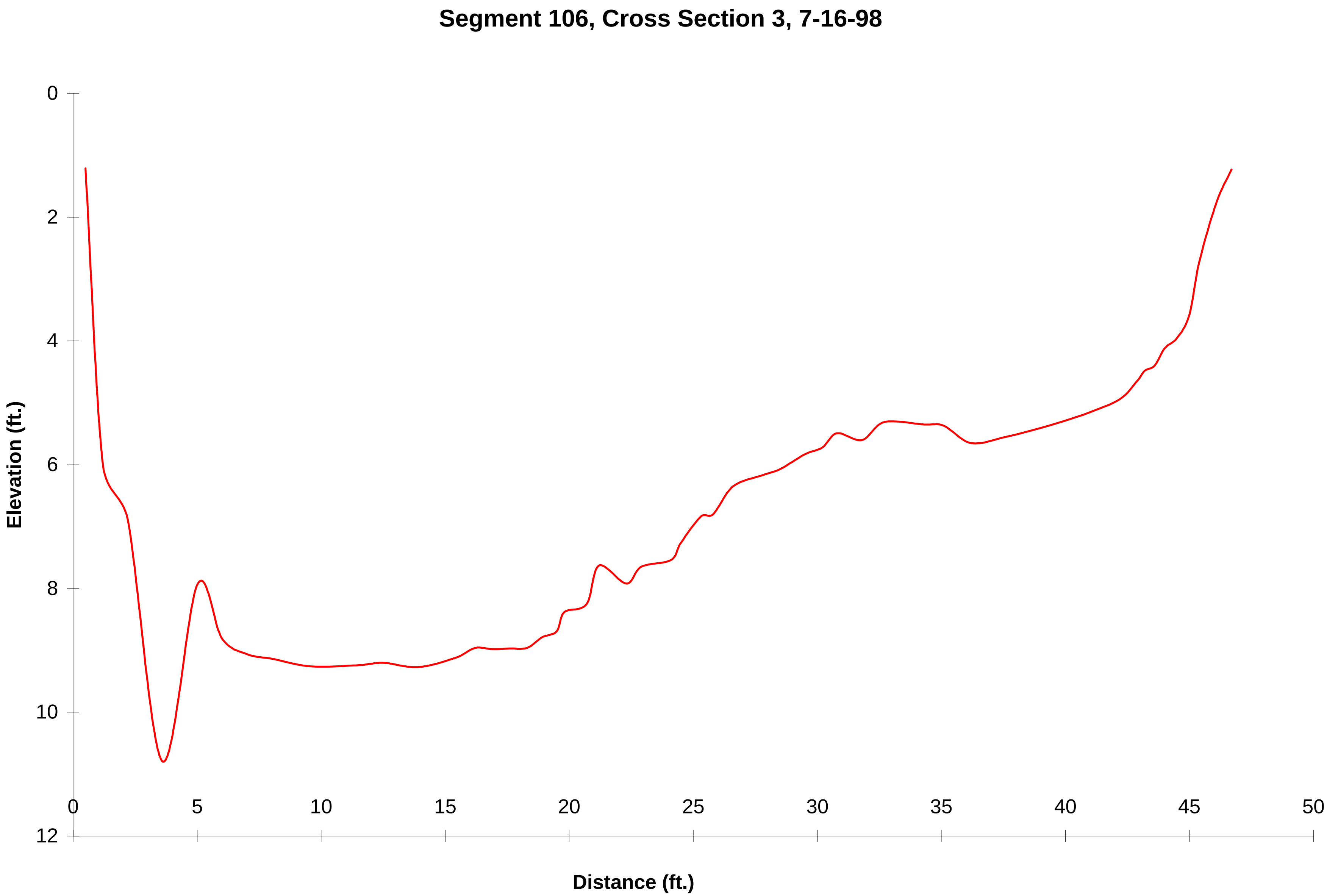
Distance (ft.)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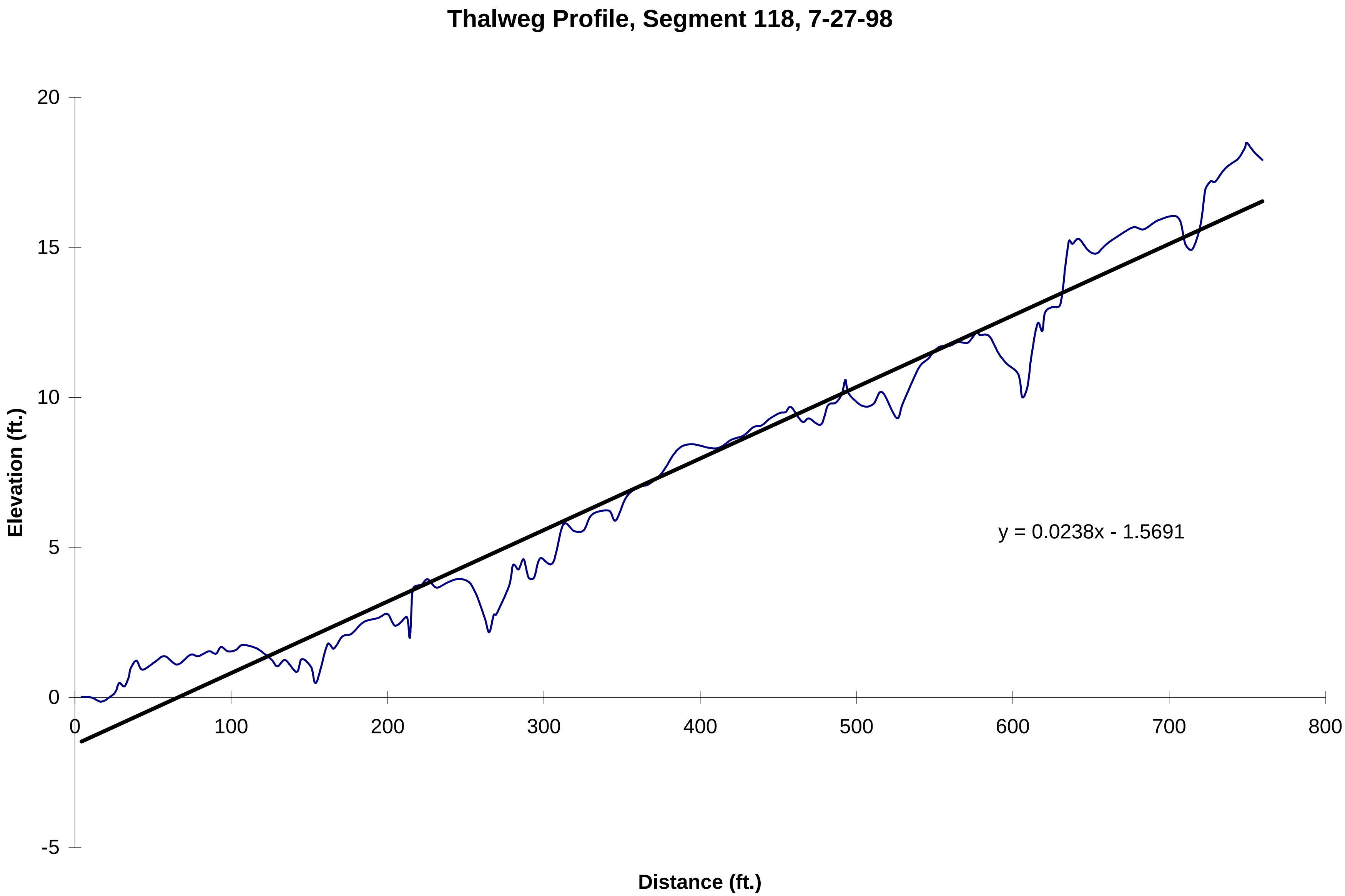
40
45
50
Distance (ft.)



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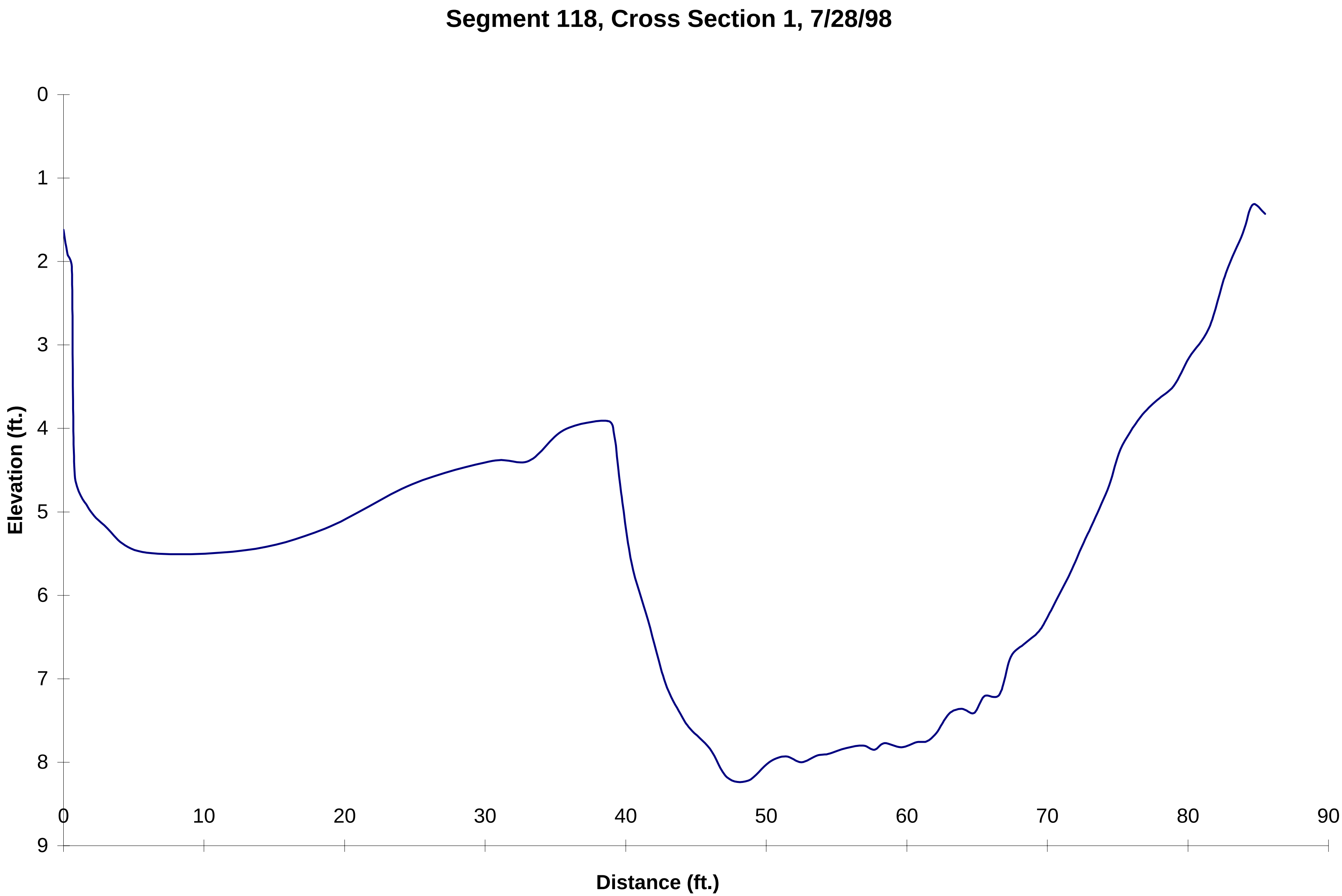
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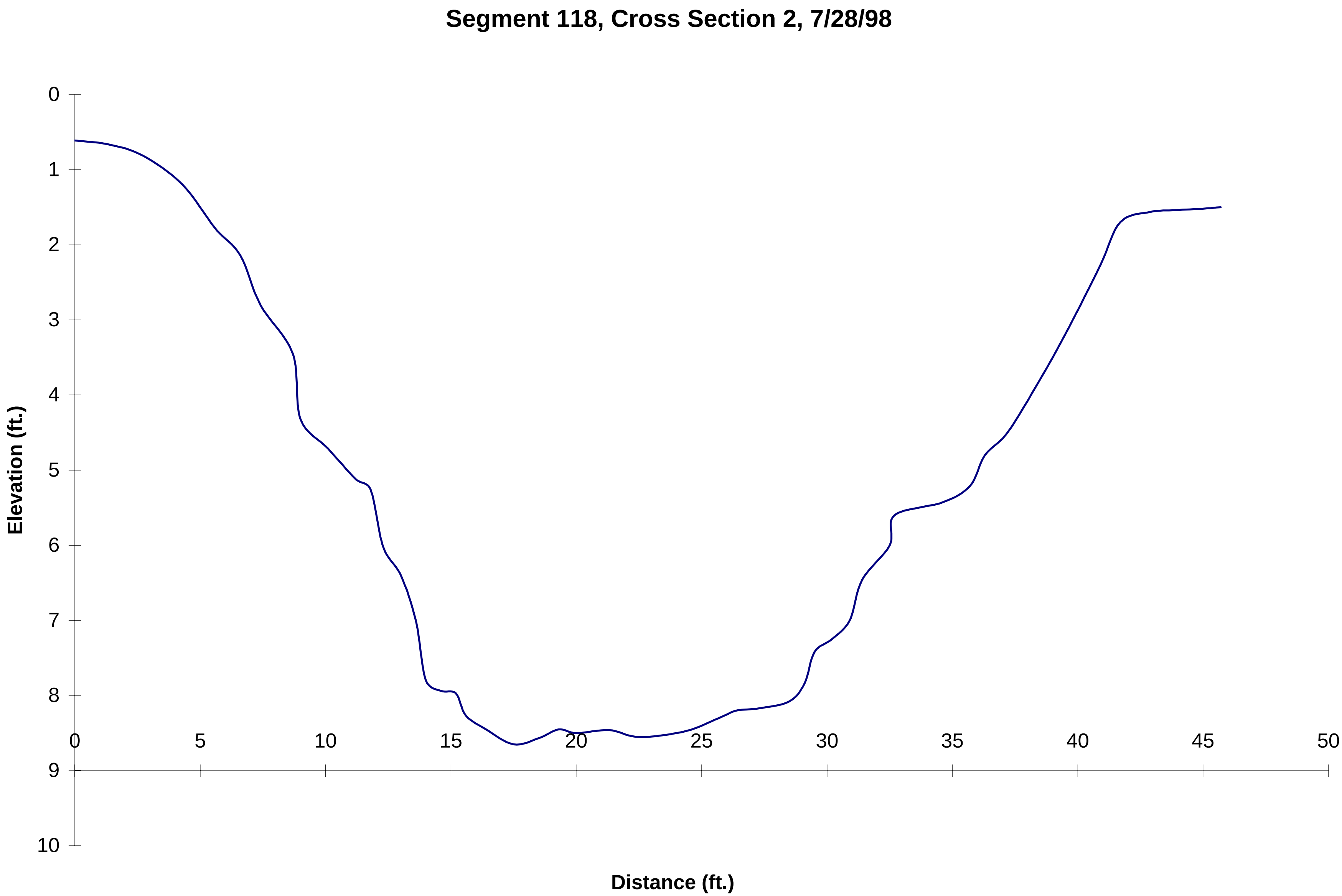
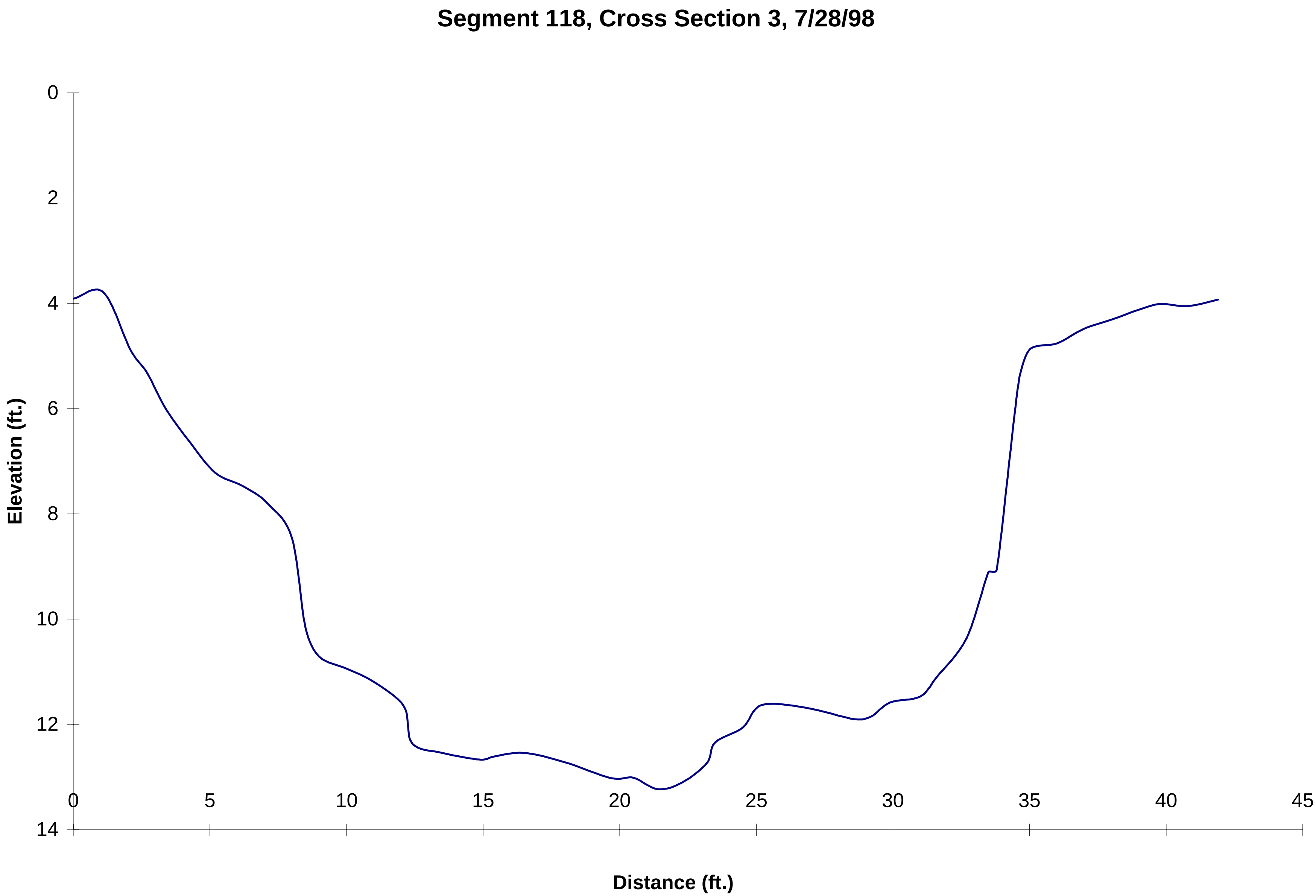
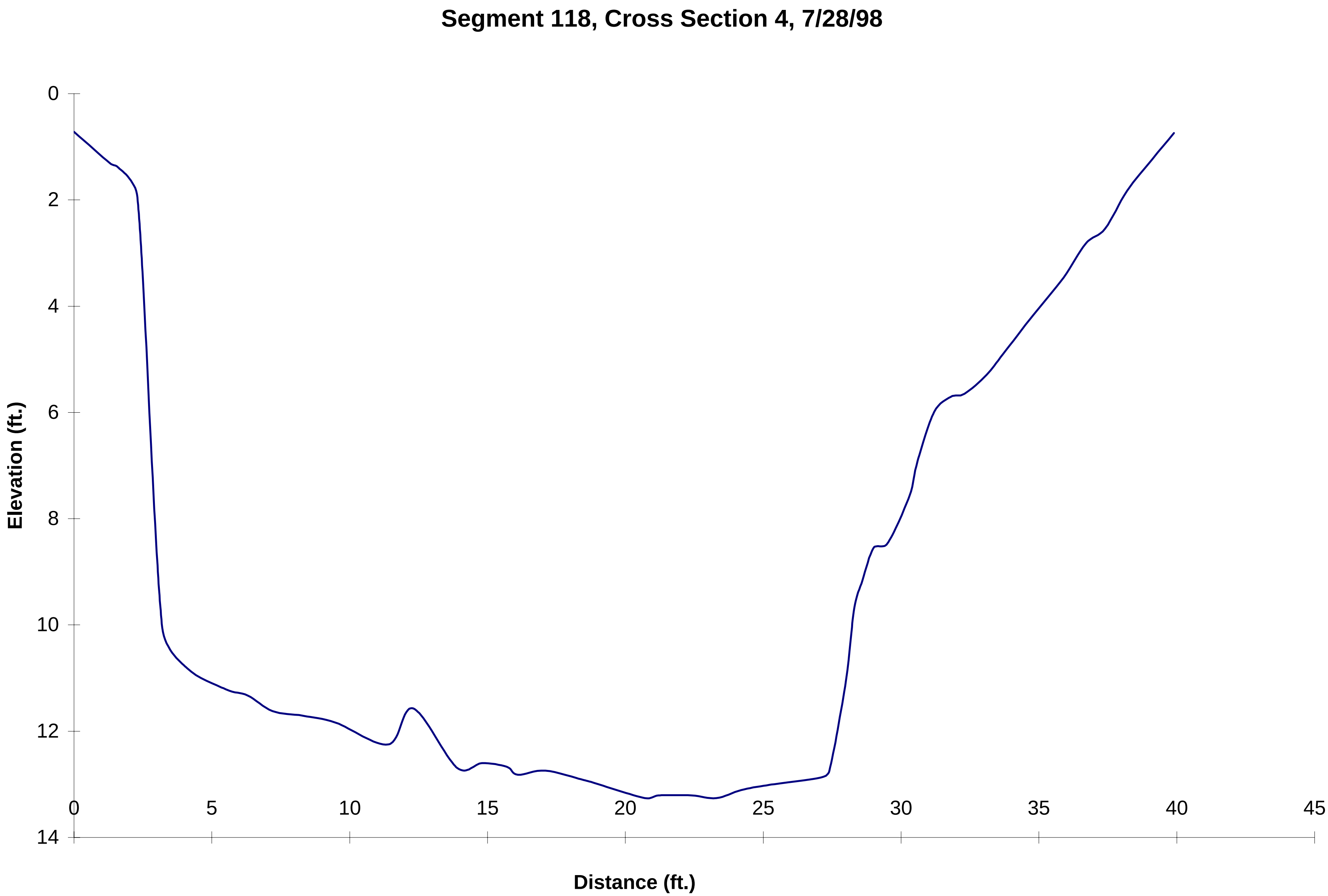
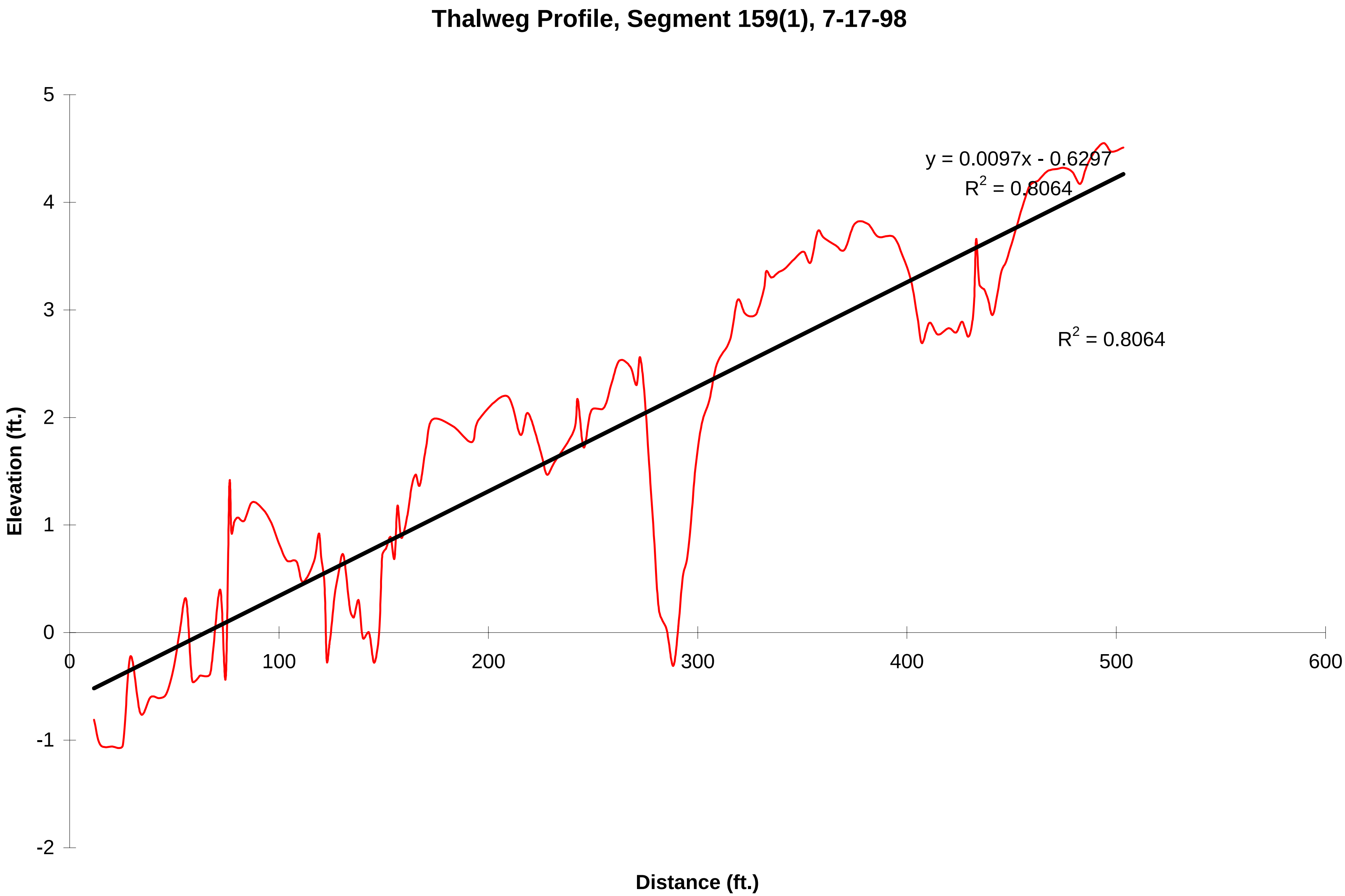
50
60
70
80
90


Segment 118, Cross Section 2, 7/28/98
Elevation (ft.)
Distance (ft.)
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35
40
45
50

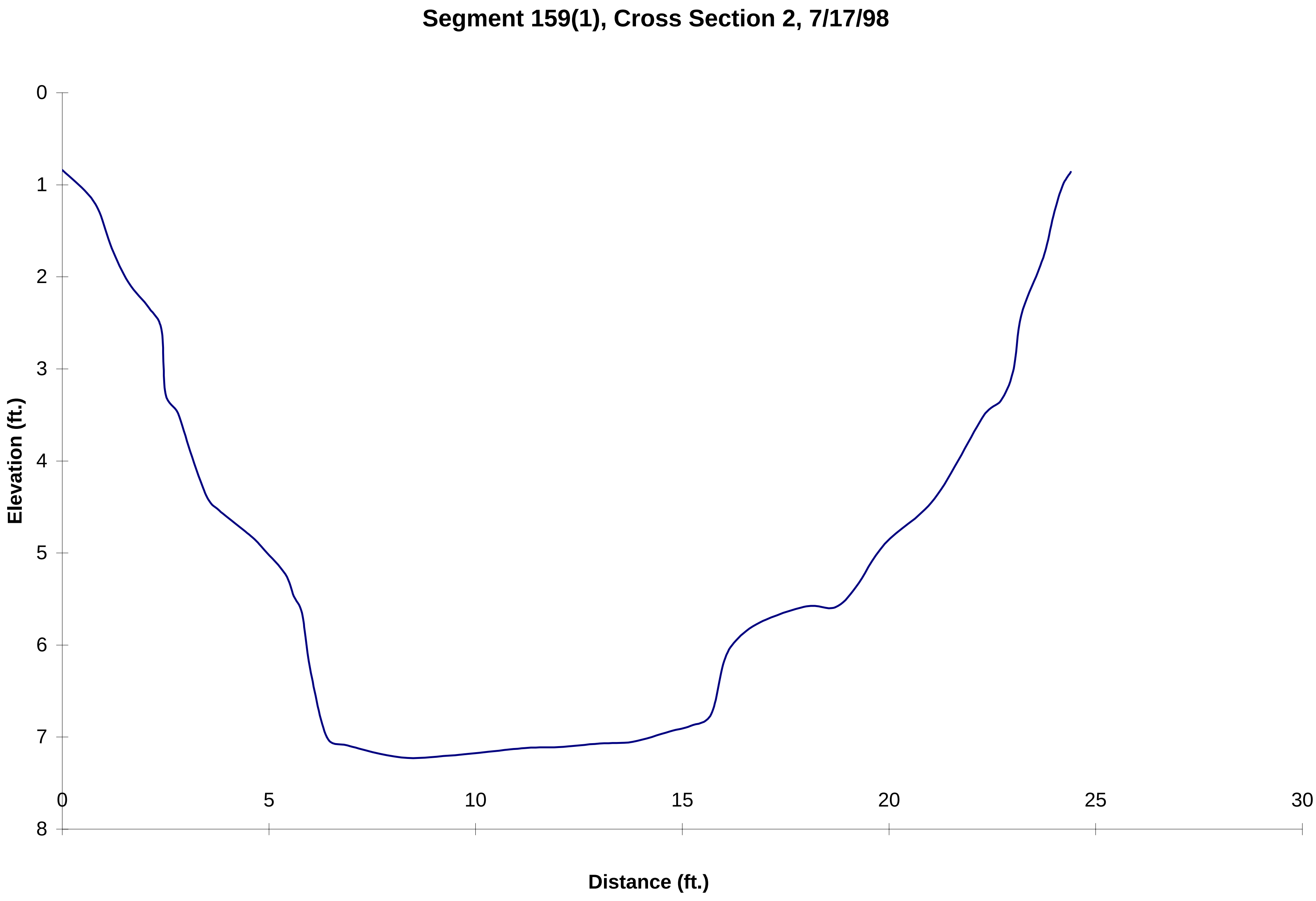

Segment 118, Cross Section 3, 7/28/98
Elevation (ft.)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
45
Distance (ft.)

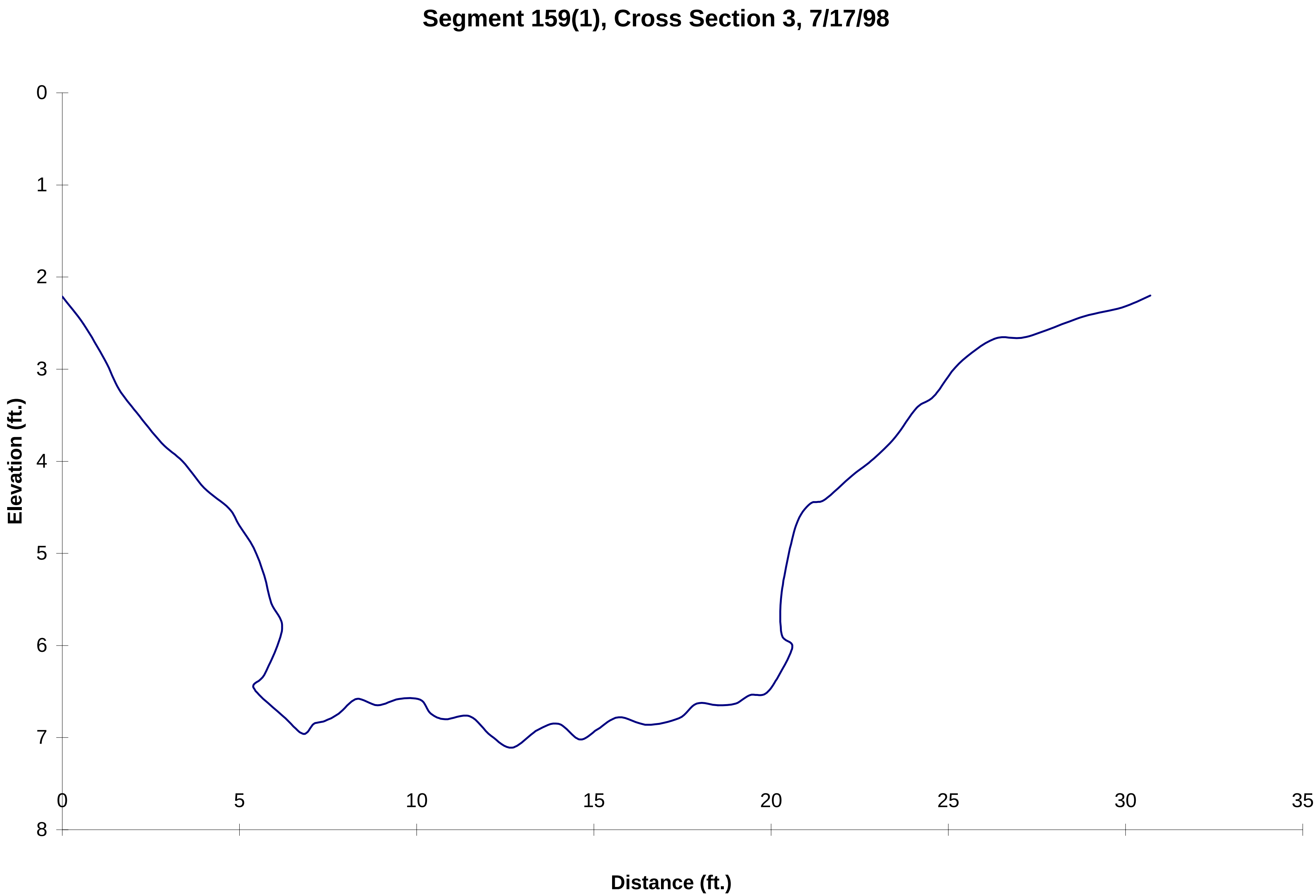


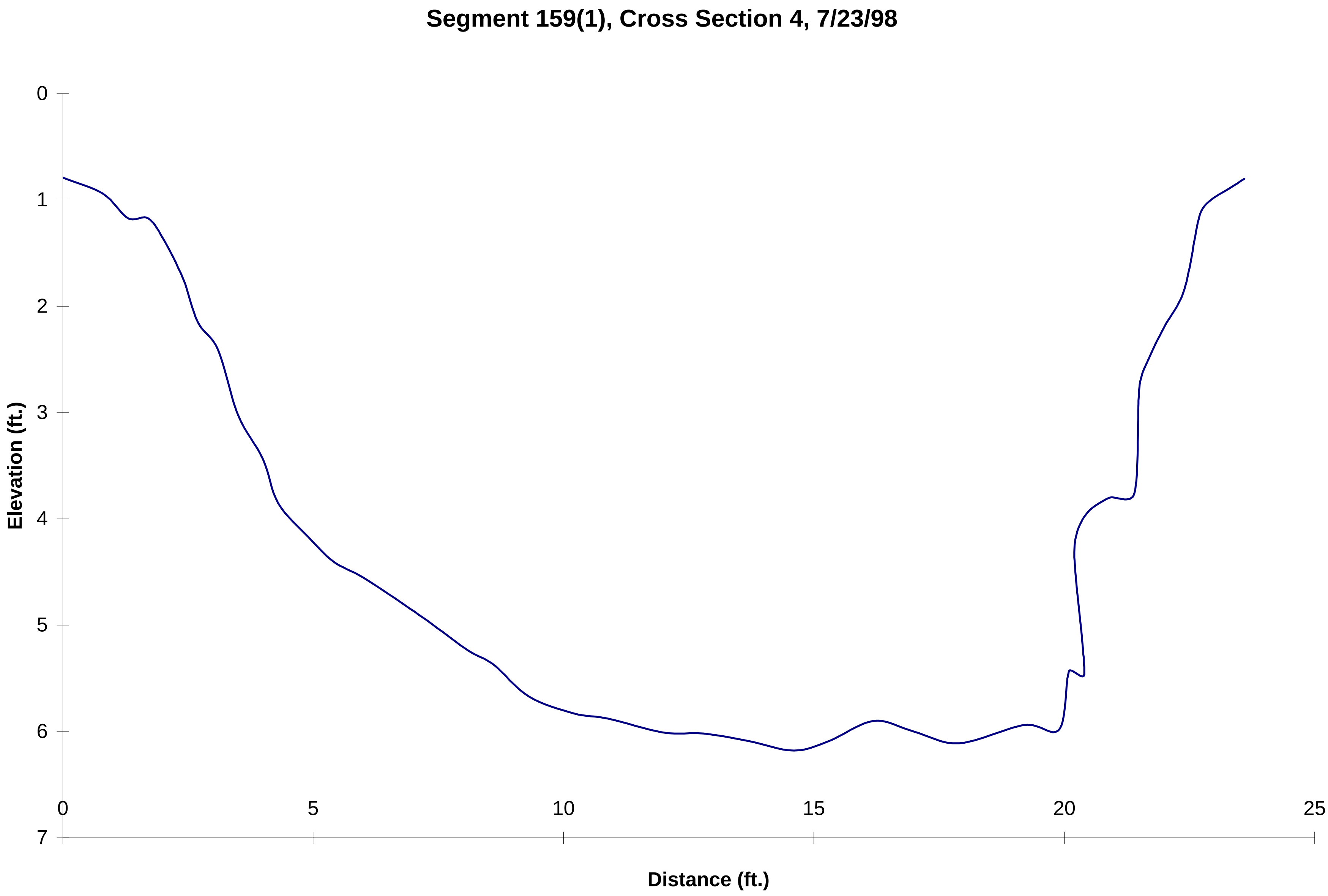
Segment 118, Cross Section 4, 7/28/98
Elevation (ft.)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
45
Distance (ft.)

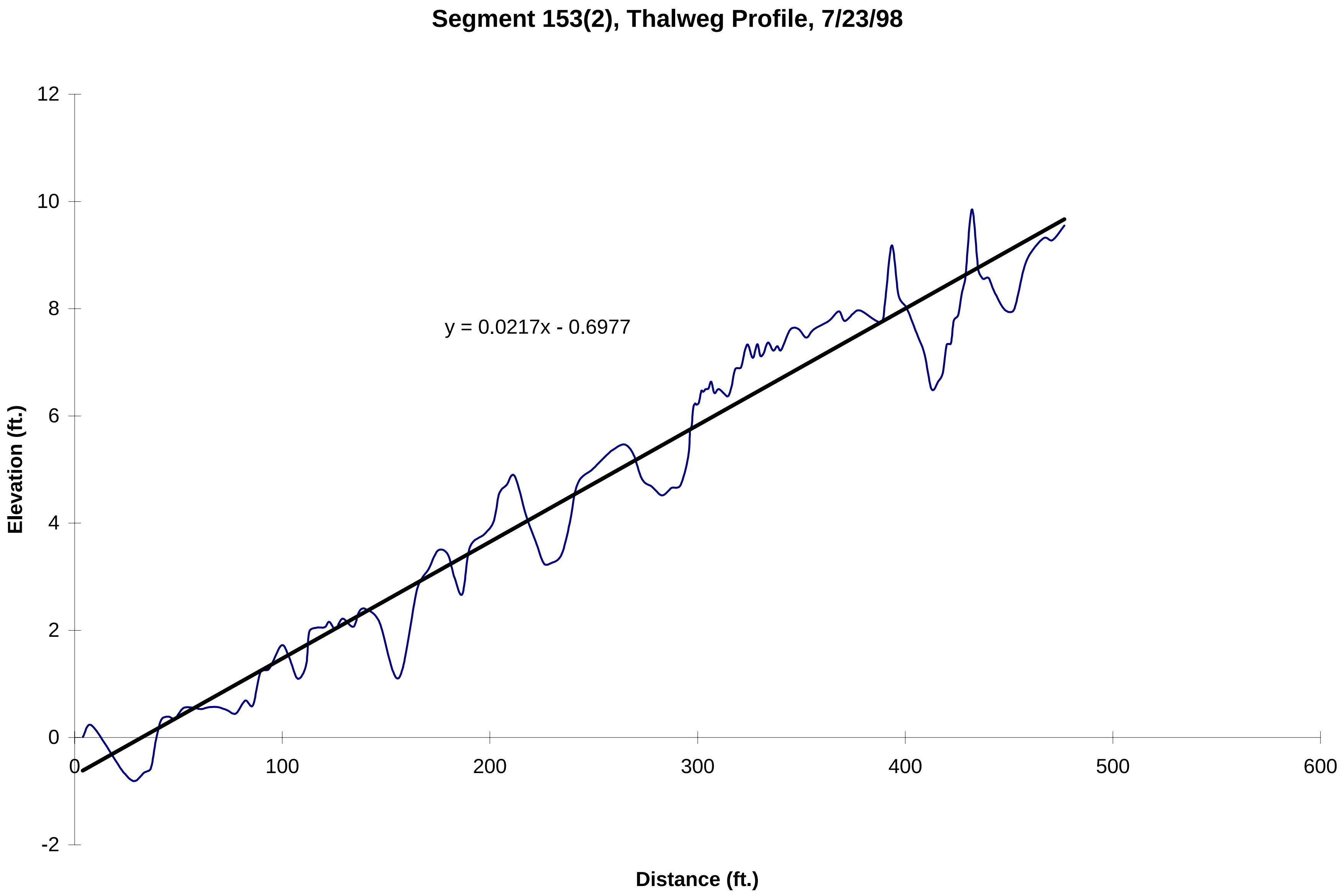

Thalweg Profile, Segment 159(1), 7-17-98
y = 0.0097x - 0.6297
R^2 = 0.8064
R^2 = 0.8064
Elevation (ft.)
Distance (ft.)
5
4
3
2
1
0
-1
-2
0
100
200
300
400
500
600

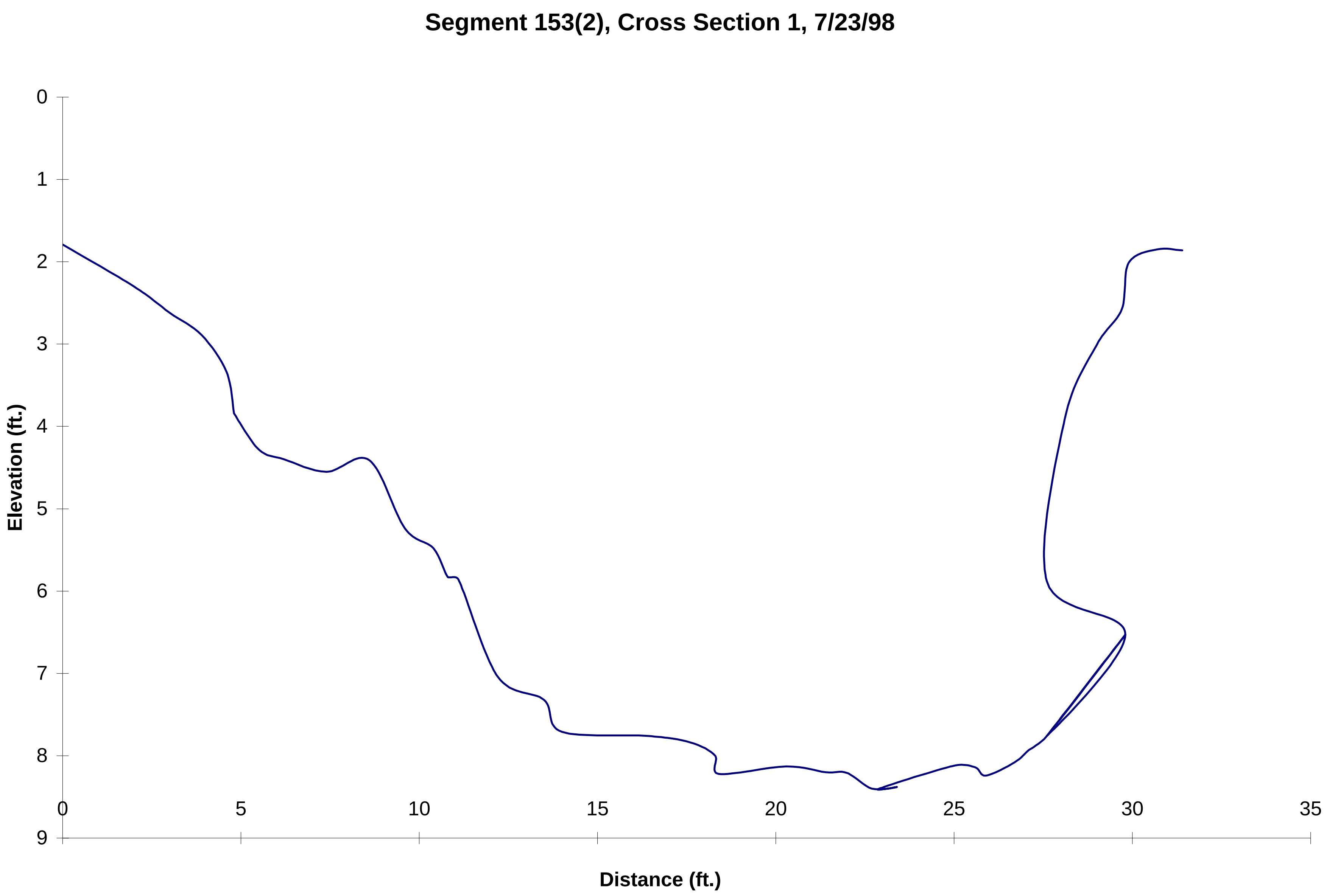
Segment 159(1), Cross Section 1, 7-17-98
Distance (ft.)
Elevation (ft.)
0
1
2
3
4
5
6
0
5
10
15
20
25
30
35
40
45

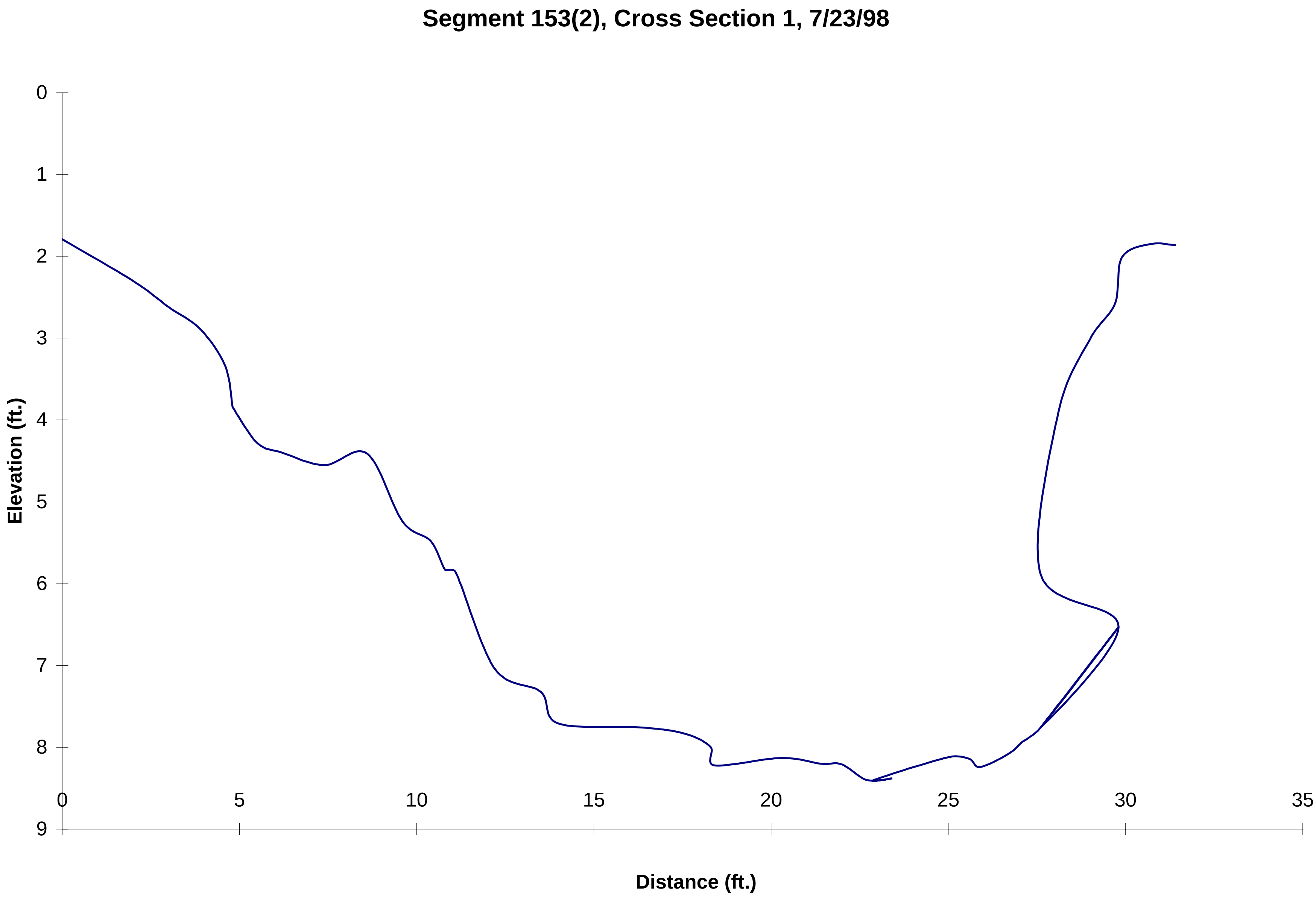

Segment 159(1), Cross Section 2, 7/17/98
Elevation (ft.)
0
1
2
3
4
5
6
7
8
0
5
10
15
20
25
30
Distance (ft.)


Segment 159(1), Cross Section 3, 7/17/98
Elevation (ft.)
0
1
2
3
4
5
6
7
8
Distance (ft.)
0
5
10
15
20
25
30
35

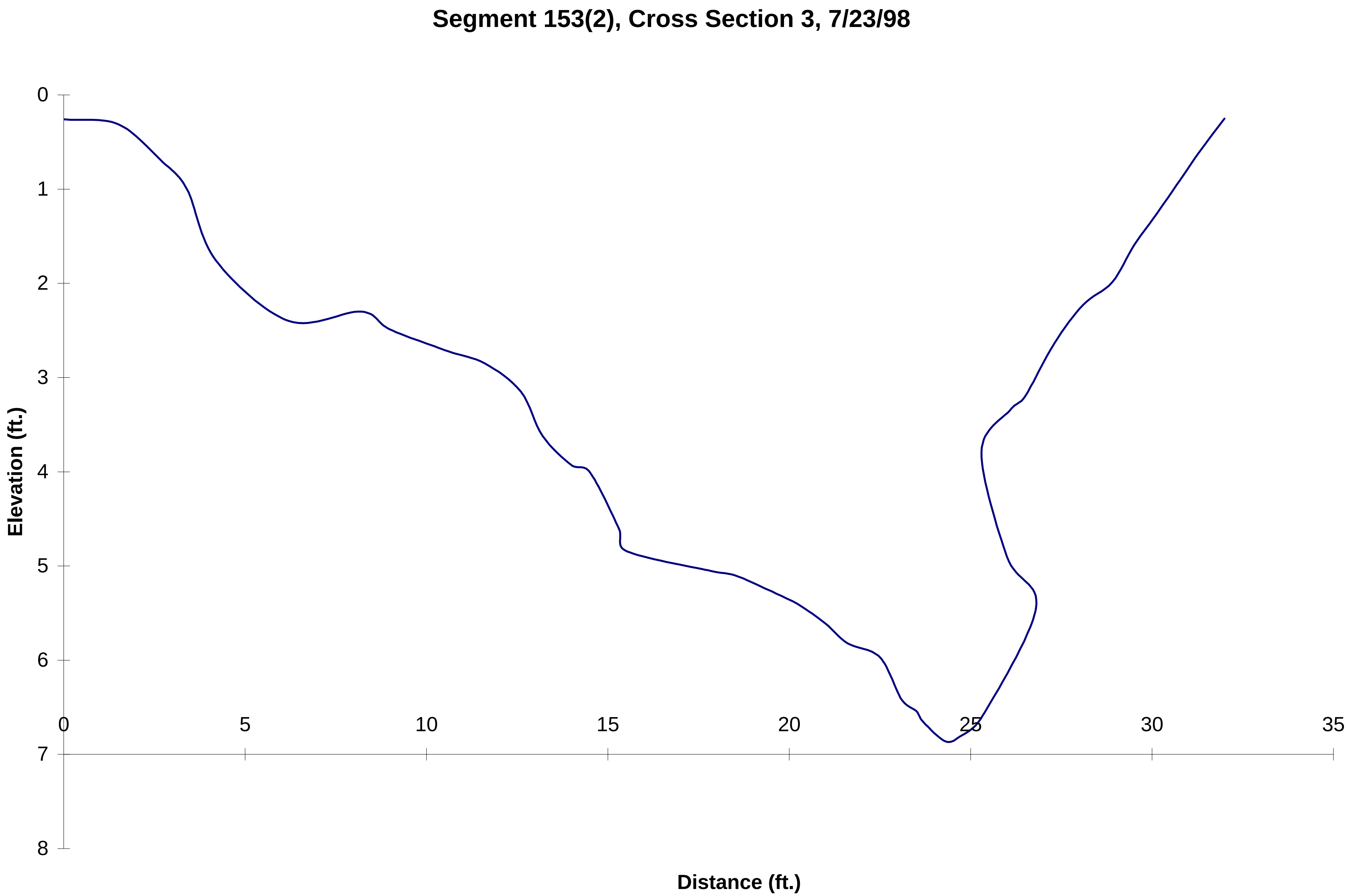

Segment 159(1), Cross Section 4, 7/23/98
Elevation (ft.)
0
1
2
3
4
5
6
7
Distance (ft.)
0
5
10
15
20
25


Segment 153(2), Thalweg Profile, 7/23/98
y = 0.0217x - 0.6977
Elevation (ft.)
Distance (ft.)
12
10
8
6
4
2
0
-2
0
100
200
300
400
500
600


Segment 153(2), Cross Section 1, 7/23/98
Elevation (ft.)
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25
30
35
Distance (ft.)



Segment 153(2), Cross Section 1, 7/23/98
Elevation (ft.)
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25
30
35
Distance (ft.)


Segment 153(2), Cross Section 3, 7/23/98
Elevation (ft.)
0
1
2
3
4
5
6
7
8
0
5
10
15
20
25
30
35
Distance (ft.)